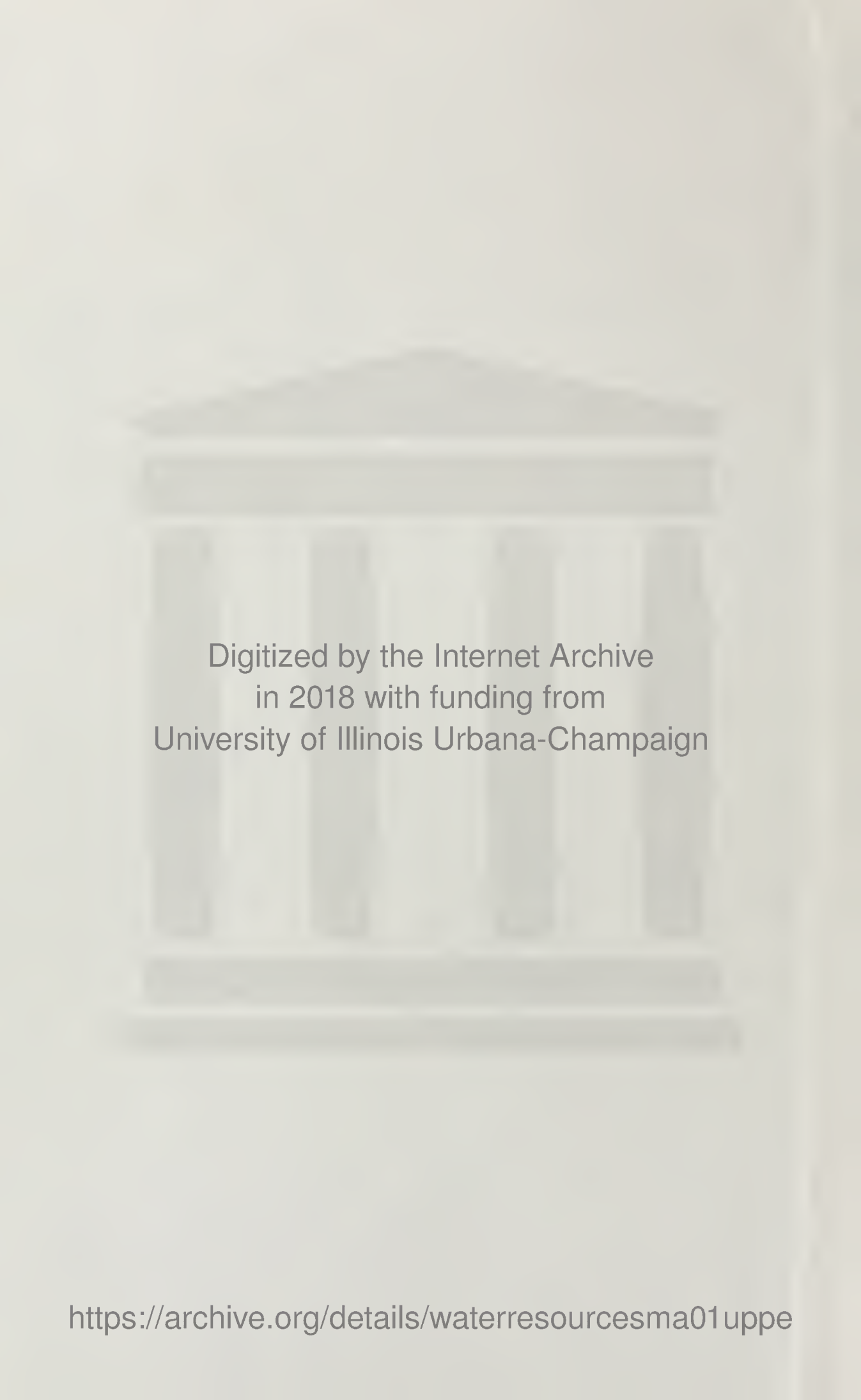
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Water Resources Management Plan

Upper Mississippi Region
Volume I

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45-Day Review Draft
September 1981

Upper Mississippi River Basin Commission

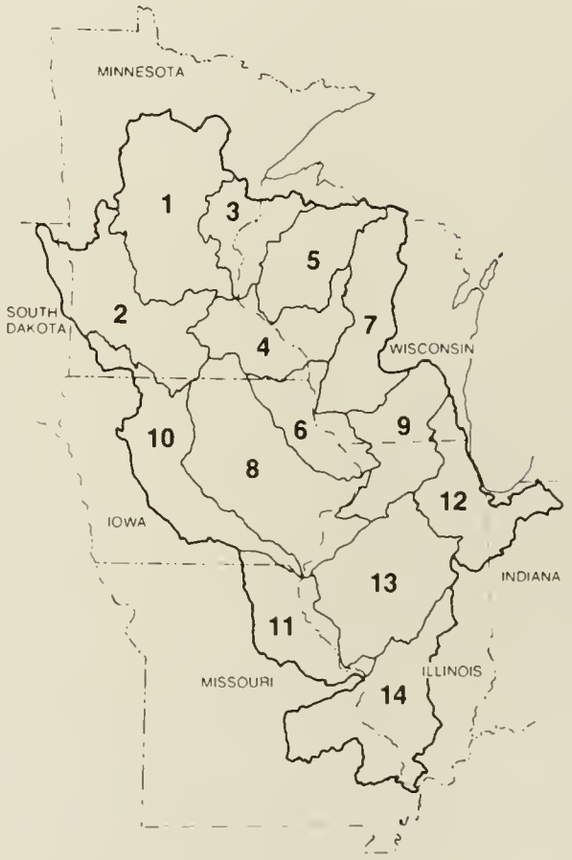
WATER RESOURCES MANAGEMENT PLAN

VOLUME I. UPPER MISSISSIPPI REGION

VOLUME II. UPPER MISSISSIPPI SUBREGIONS

- No. 1. Mississippi Headwaters
- No. 2. Minnesota River Basin
- No. 3. Saint Croix River Basin
- No. 4. Black-Root River Basin
- No. 5. Chippewa River Basin
- No. 6. Maquoketa-Plum River Basin
- No. 7. Wisconsin River Basin
- No. 8. Iowa-Skunk-Wapsipinicon River Basin
- No. 9. Rock River Basin
- No. 10. Des Moines River Basin
- No. 11. Salt-Sny River Basin
- No. 12. Upper Illinois River Basin
- No. 13. Lower Illinois River Basin
- No. 14. Kaskaskia-Meramec River Basin

VOLUME III. REFERENCE HANDBOOK



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Upper Mississippi River Basin Commission
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Minneapolis, Minnesota 55420

Water Resources Management Plan

Volume I
Upper Mississippi Region

45-Day Review Draft
September 1981

NOTICE

This document is for INFORMATION ONLY and does not constitute official views, recommendations, approval or position of the STATE OF ILLINOIS or ILLINOIS STATE WATER AGENCIES. The President of the United States by Executive Order 12319 of September 9, 1981 ordered the termination of the Upper Mississippi River Basin Commission on December 31, 1981. Pursuant to the Executive Order, on October 1, 1981 the Upper Mississippi River Basin Commission suspended all Comprehensive Coordinated Joint Plan activities including preparation of its Water Resources Management Plan. Volume I Upper Mississippi Region, 45-day Review Draft, September 1981 of the UMRBC Water Resources Management Plan is being given regional distribution, without further review, comment input or approval by Upper Mississippi River Basin Commission members and without Illinois State Water Agencies further review, comment input and without approval. Copies of Volume I Upper Mississippi Region 45-day Review Draft, Volume II Upper Mississippi Subregions Review Drafts and Volume III Reference Handbook are deposited with the Illinois State Library for Information Only. These documents are available for use through regular library loan procedures. No copies will be available from the Upper Mississippi River Basin Commission or from any Illinois State Water Agency.

Frank Kudrna
Commissioner
State of Illinois
October, 1981

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Upper Mississippi River Basin Commission

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PREFACE

The Upper Mississippi River Basin Commission was established by Presidential Executive Order No. 11659 on 22 March 1972 at the request of the governors of the five states in the region for the purpose of coordinating water planning and management. The Commission's primary purpose is to carry out the duties prescribed in the 1965 Water Resources Planning Act, Public Law 89-80 (see Appendix A).

Section 201(b)(2) of the Water Resources Planning Act states that river basin commissions shall ". . . prepare and keep up to date, to the extent practicable, a comprehensive, coordinated, joint plan for Federal, State, interstate, local, and nongovernmental development of water and related land resources." This plan was prepared to meet this mandate and is the first basinwide Water Resources Management Plan. The Water Resources Management Plan comprises Volume I Upper Mississippi Region, Volume II Upper Mississippi Subregions, and Volume III Reference Handbook.

Volume I Upper Mississippi Region delineates critical regional water resources issues, problems, needs, and recommended policies and actions. Volume II Upper Mississippi Subregions presents a more detailed analysis of problems and needs for each of the fourteen river basins. The plan integrates and synthesizes the results of completed and ongoing federal, state, local, and nongovernmental planning and management efforts. Some of the major studies taken into consideration include the GREAT River Environmental Action Team Studies, state water quality management plans, and state water plans. The plan also assumes that no change in the export of water out of the region will occur.

The plan is now in 45-day field-level review by the Commission and the public, and will undergo 90-day formal review by the head of each federal department or agency of the Commission and the Governors of the states in the region. The Commission approved plan and formal review comments are then submitted to the U.S. Water Resources Council before transmittal to the President and Congress.

ACKNOWLEDGMENTS

This regional water resources plan for the Upper Mississippi Region was prepared by the CCJP Priorities Committee of the Upper Mississippi River Basin Commission. The report could not have been completed without the assistance of many who contributed advice, comments, and critical appraisal. The Commission is grateful to the guidance of William Ackermann (private consulting engineer), Robert Harmeson (former acting director of Illinois Water Survey), and William Walton (UMRBC Executive Director 1974-1979). Two phases of research were instrumental in the development of the data: the "Socio-Economic Information System" by Mason Chen, Leonard Laulainen, and Wilbur Maki of the University of Minnesota, Department of Agricultural and Applied Economics; and the "Land Use, Soil Erosion, and Agricultural Production Scenarios" by Bernie Dickerson and Bob Lindahl of the USDA Forest Service, Russ Knutson of the USDA Soil Conservation Service, and Tony Grano and Walt Miller of the USDA Economics, Statistics, and Cooperative Service.

The Commission also extends its appreciation to Steve Pochardt for assistance in programming and data analysis, and Scott Meyer and Ronald Peterson for assistance in research and cartography.

TABLE OF CONTENTS

	Page
Preface	iii
Acknowledgments	iv
Table of Contents	v
List of Figures	vii
List of Tables	xi
Introduction	xv
Goals and Planning Objectives	xvii
Goal	xvii
State and Regional Planning Objectives	xvii
I. THE REGION: PRESENT AND FUTURE	
Physical Setting	3
Climate	5
Mineral Resources	5
Wildlife and Recreational Resources	7
Water Resources	11
Surface Water	11
Groundwater	24
Socio-Economic Setting	29
Population and Economy	29
Land Use	34
Agriculture	35
Navigation	37
Recreation	37
Offstream Water Use	42
Domestic	42
Manufacturing	43
Mining	44
Irrigation	45
Livestock	49
Energy	51
Total Water Use: Summary	54
II. PROBLEMS, NEEDS, AND ALTERNATIVE SOLUTIONS	
Introduction	59
Water Supply*	62
Water Quality*	76

*includes Current Conditions and Problems; Anticipated Problems; Governmental Authority, Responsibility, and Policy; Alternative Solutions and Effects; and Conclusion.

Page

Erosion and Sedimentation*. 95
Flood Damage* 129
Water Recreation* 151
Fish and Wildlife*. 167
Commercial Navigation*. 179
Energy* 191
Instream Flows* 203

III. REGIONAL POLICIES AND RECOMMENDATIONS

Introduction. 219
Water Supply. 220
Water Quality 222
Erosion and Sedimentation 224
Flood Damage. 227
Water Recreation. 231
Fish and Wildlife 234
Commercial Navigation 238
Energy. 242
Instream Flows. 244

IV. ENVIRONMENTAL ASSESSMENT SUMMARY

Effects of Recommended Solutions on Objectives for Water and Related Land Resources. 249
Environmental Assessment Summary. 253

Appendices

A. Excerpts from the 1965 Water Resources Planning Act 257
B. Preparation of Water Resources Management Plan. 259
C. Excerpts from the U.S. Water Resources Council, Policy Statement No. 4: The Utilization of Comprehensive Regional Water Resources Management Plans, 1 January 1979. 261
D. Excerpts from the U.S. Water Resources Council's "Proposed Rules: Principles, Standards, and Procedures for Planning Water and Related Land Resources" . . . 265
E. Definition of Components in the "Proposed Rules; Principles, Standards, and Procedures for Planning Water and Related Land Resources" 269

Sources Consulted. 273

LIST OF FIGURES

Figure		Page
I-1	Upper Mississippi River Basin	4
I-2	Major Mineral Deposits, Upper Mississippi Region.	5
I-3	Climatic Data and Runoff, Upper Mississippi Region.	6
I-4	State and Federal Wildlife Areas, Upper Mississippi Region.	9
I-5	Wetlands Valuable for Waterfowl--1955, Upper Mississippi Region	11
I-6	State and National Forests and Parks, Upper Mississippi Region.	13
I-7	Designated Recreation Sites, Upper Mississippi Region	17
I-8	Major Dams and Reservoirs, Upper Mississippi Region	21
I-9	Average Flow of Selected Streams, Upper Mississippi Region.	23
I-10	Surface Water Ratio by County, Upper Mississippi Region	25
I-11	Outwash and Alluvial Deposits, Upper Mississippi Region	27
I-12	Groundwater Geology of the Upper Bedrock, Upper Mississippi Region.	28
I-13	Population Projection to 2020, Upper Mississippi Region	30
I-14	Population Density by County, Upper Mississippi Region.	31
I-15	Earnings Projection to 2020, Upper Mississippi Region	33
I-16	Earnings by Major Industries, Upper Mississippi Region.	34
I-17	Land Use in 1979, Upper Mississippi Region.	34
I-18	Land Use, Subregions of the Upper Mississippi Region.	36
I-19	Total Commodity Movement in 1976, Upper Mississippi River System.	38
I-20	Upper Mississippi River Navigation System	39
I-21	Navigation Commerce in 1977 by Commodity, Upper Mississippi Region.	40
I-22	Waterborne Commodity Movement to 2003, Upper Mississippi Region	40
I-23	Selected Annual Resident Water and Related Recreation, Trends to 2000, Upper Mississippi Region.	40
I-24	Domestic Water Use to 2020 by Subregion, Upper Mississippi Region	43
I-25	Gross Water Use, Withdrawal, and Consumption for Manufacturing in 1975, Upper Mississippi Region.	44

Figure		Page
I-26	Irrigated Acres in 1977 by County, Upper Mississippi Region	47
I-27	Irrigation Water Use to 2000 by Subregion, Upper Mississippi Region	49
I-28	Livestock on Farms 1960-1977, States of the Upper Mississippi Region	50
I-29	Livestock Water Use in 1976 by Subregion, Upper Mississippi Region	51
I-30	Major Steam-Electric Power Plants, Upper Mississippi Region	53
I-31	Power Plant Water Use by Subregion, Upper Mississippi Region	54
I-32	Electrical Generation by Cooling Type, Upper Mississippi Region	55
I-33	Average Annual Daily Water Use by Subregion, Upper Mississippi Region	56
II-1	Low-Yield Sources of Groundwater, Upper Mississippi Region	63
II-2	Major Water Supply Problem Areas, Upper Mississippi Region	66
II-3	Water Quality Problem Areas, Upper Mississippi Region	77
II-4	Soil Erosion from Cropland by Subregion, Upper Mississippi Region	96
II-5	Soil Erosion from Pastureland and Forestland by Subregion, Upper Mississippi Region	97
II-6	Annual Sediment Yield, Upper Mississippi Region	100
II-7	Soil Erosion Potential, Upper Mississippi Region	103
II-8	Status of Soil Surveys, Upper Mississippi Region	109
II-9	Existing Watershed Protection Projects (P.L. 83-566) Upper Mississippi Region	111
II-10	Potential Watershed Protection Projects (P.L. 83-566) Upper Mississippi Region	113
II-11	Status of Resource Conservation and Development Areas, Upper Mississippi Region	115
II-12	Conservation Practices Needed at Alternative Levels of Erosion, 1977 Export Level Scenario, Upper Mississippi Region	119
II-13	Conservation Practices Needed at Alternative Levels of Erosion, Moderate Export Increase Scenario, Upper Mississippi Region	120
II-14	Average Annual Flood Damages by Land Use, Upper Mississippi Region	129
II-15	Average Annual Flood Damages by Subregion, Upper Mississippi Region	130

Figure		Page
II-16	Average Annual Flood Damages of Selected Streams, Upper Mississippi Region	131
II-17	Average Annual Flood Damages to 2000, Upper Mississippi Region	132
II-18	Completed Army Corps of Engineers Flood Control Projects, Upper Mississippi Region	135
II-19	Flood Control Project Implementation, Upper Mississippi Region	144
II-20	Flood Control Studies, Upper Mississippi Region	145
II-21	Average Annual Flood Damages Under Alternative Levels of Floodplain Regulation, Upper Mississippi Region	148
II-22	Recreation Facilities--Surplus or Deficiency, Upper Mississippi Region	154
II-23	Potential Recreation Sites, Upper Mississippi Region	157
II-24	Potential and Underway Commercial Navigation Projects, Upper Mississippi Region	188
II-25	Steam-Electric Power Plants by Size and State Share, Upper Mississippi Region	191
II-26	"Limited Survival" Instream Flow, Upper Mississippi Region	205
II-27	"Good" Instream Flow, Upper Mississippi Region	207

LIST OF TABLES

Table		Page
I-1	Land Characteristics, Upper Mississippi Region.	3
I-2	National Wildlife Refuges, Upper Mississippi Region	7
I-3	State Wildlife Areas, Upper Mississippi Region.	7
I-4	Population Characteristics, Upper Mississippi Region.	29
I-5	Employment and Earnings, Upper Mississippi Region	34
I-6	Crop Acreage and Production, Upper Mississippi Region	35
I-7	Physical Characteristics of the Navigation Channel, Upper Mississippi Region.	41
I-8	Popularity of Water Recreation Activities, Upper Mississippi Region.	41
I-9	Domestic Water Use to 2020, Upper Mississippi Region.	42
I-10	Water Use Characteristics for Manufacturing to 2000, Upper Mississippi Region.	43
I-11	Mining Water Use to 2000, Upper Mississippi Region.	45
I-12	Irrigation Water Use to 2000, Upper Mississippi Region.	46
I-13	Livestock Water Use to 2020 (High Estimate), Upper Mississippi Region.	52
I-14	Water Withdrawal and Consumption to 2000 (Best Estimate), Upper Mississippi Region.	55
II-1	Severity of Problems in River Basins of the Upper Mississippi Region.	60
II-2	Governmental Authority and Responsibility for Water Supply, Upper Mississippi Region.	68
II-3	Alternative Solutions to Water Supply Problems and Needs: Analysis and Evaluation, Upper Mississippi Region.	73
II-4	Municipal Wastewater Treatment Projects, Upper Mississippi Region.	79
II-5	Governmental Authority and Responsibility for Water Quality, Upper Mississippi Region.	84
II-6	Alternative Solutions to Water Quality Problems and Needs: Analysis and Evaluation, Upper Mississippi Region.	89

Table		Page
II-7	1978 Wastewater Treatment Plant Construction Needs, Upper Mississippi Region.	91
II-8	Principal Best Management Practices	92
II-9	Estimate of Current Major Land Use and Gross Soil Erosion by Subregion, Upper Mississippi Region.	95
II-10	Sheet, Rill, and Wind Erosion on Nonfederal Agricultural Land, Upper Mississippi Region.	98
II-11	Soil Loss by Land Class-Subclass in 1977, Upper Mississippi Region.	98
II-12	Governmental Authority and Responsibility for Erosion and Sedimentation, Upper Mississippi Region	106
II-13	Effects of Erosion Control on Cropland, Fertilizer, and Pesticide Use in 2000, 1977 Export Level Scenario, Upper Mississippi Region.	118
II-14	Estimated Agricultural Production in 2000 Under Various Levels of Erosion Control, 1977 Export Level Scenario, Upper Mississippi Region.	118
II-15	Effects of Erosion Control on Production Costs of Agricultural Products in 2000, 1977 Export Level Scenario, Upper Mississippi Region.	118
II-16	Effects of Erosion Control on Cropland, Fertilizer, and Pesticide Use in 2000, Moderate Export Increase Scenario, Upper Mississippi Region.	119
II-17	Estimated Agricultural Production in 2000 Under Various Levels of Erosion Control, Moderate Export Increase Scenario, Upper Mississippi Region.	121
II-18	Effects of Erosion Control on Production Costs of Agricultural Products in 2000, Moderate Export Increase Scenario, Upper Mississippi Region.	121
II-19	Forestland Disturbance Classes at Alternative Export and Erosion Control Levels, Upper Mississippi Region.	121
II-20	Alternative Solution to Erosion and Sedimentation: Analysis and Evaluation, Upper Mississippi Region.	123
II-21	Erosion and Sedimentation Control Measures.	125
II-22	Governmental Authority and Responsibility for Flood Damage Reduction, Upper Mississippi Region	137
II-23	Alternative Solutions to Flooding: Analysis and Evaluation, Upper Mississippi Region.	142
II-24	Average Annual Flood Damages Under Alternative Levels of Floodplain Regulation, Upper Mississippi Region	147

Table		Page
II-25	Water Recreation Supply and Need, Upper Mississippi Region.	.155
II-26	Governmental Authority and Responsibility for Water Recreation Management, Upper Mississippi Region	.160
II-27	Alternative Solutions to Water Recreation Problems and Needs: Analysis and Evaluation, Upper Mississippi Region.	.164
II-28	Federal Endangered and Threatened Species, Upper Mississippi Region.	.168
II-29	Governmental Authority and Responsibility for Fish and Wildlife Management and Protection, Upper Mississippi Region.	.171
II-30	Alternative Solutions to Fish and Wildlife Problems and Needs: Analysis and Evaluation, Upper Mississippi Region.	.175
II-31	Governmental Authority and Responsibility for Commercial Navigation, Upper Mississippi Region.	.182
II-32	Alternative Solutions to Commercial Navigation Problems and Needs: Analysis and Evaluation, Upper Mississippi Region.	.186
II-33	Potential Hydroelectric Production at Existing Dams, Upper Mississippi Region.	.193
II-34	Governmental Authority and Responsibility for Energy, Upper Mississippi Region.	.197
II-35	Alternative Solutions to Energy Problems and Needs: Analysis and Evaluation Upper Mississippi Region.	.200
II-36	Governmental Authority and Responsibility for Instream Flows, Upper Mississippi Region	.211
II-37	Alternative Solutions to Instream Flows Problems and Needs: Analysis and Evaluation, Upper Mississippi Region.	.214
IV-1	Effects of Recommended Solutions on Objectives for Water and Related Land Resources, Upper Mississippi Region.	.251

INTRODUCTION

> Engineering has been America's traditional solution to its water worries. Dams were built to supply dry areas with water, and to catch floodwaters before they had a chance to cause disaster. But as the nation has grown more sophisticated, so have its water problems. (Public Television, NOVA: The Water Crisis, 25 November 1980)

The Upper Mississippi River Basin Commission has prepared this water resources management plan which contains a regional assessment and broad analysis of water related problems and needs. Alternatives are formulated which address problem solutions, and recommendations are determined for short and long-term resolution.

The Comprehensive Coordinated Joint Plan, Plan of Study adopted by the Commission at its 22nd Quarterly Meeting on May 10-11, 1977 defines the purpose of the plan and outlines its preparation into four phases (see Appendix B). Most responsibilities during the plan phases are delegated by the Commission to its CCJP Priorities Committee. The Committee provides study direction and coordination, and reviews products prepared by the CCJP Task Force, which is composed of UMRBC staff and state contract personnel who develop plan products.

Plans for the region and subregions delineate critical resource issues, problems, needs, and the methods to alleviate them through projects and management programs. Elements of the plans include background information--physical setting, socio-economic setting, and water use data; current conditions and problems; anticipated problems; governmental authority, responsibility, and policy; alternative solutions and effects; conclusion; policies and recommendations; and environmental assessment summary.

The final phase is formal review and approval of the Water Resources Management Plan, Upper Mississippi Region Volumes I-III. These plans undergo a 45-day field-level review by the Commission and the public, and a 90-day formal review by the head of each federal agency or department of the Commission and the governors of the states in the region. The review as an Environmental Impact Statement is conducted concurrently. Final plans are then submitted to the Commission for formal approval before submittal to the U.S. Water Resources Council and subsequently to the President and Congress.

The 1965 Water Resources Planning Act requires the Water Resources Council to review approved regional plans with special regard to efficiency in achieving optimum use of the water and related land resources in the area involved; the effect of the plan on achievement of other programs for the development of agricultural, urban, energy, industrial, fish and wildlife, and other resources of the entire nation; and the contributions of the plans in obtaining the nation's economic and social goals. Based on this review, the Water Resources Council will formulate such recommendations desirable in the national interest, and transmit these recommendations together with the plan of the river basin commission and the comments submitted by government agencies to the President for review before transmittal to Congress with recommendations on the authorization of federal projects.

The Water Resources Council issued a policy statement entitled "The Utilization of Comprehensive Regional Water Resources Management Plans," commonly referred to as "federal consistency," which mandates that future federal water and related resource activities comply with approved regional plans (see Appendix C). Federal agencies are required to submit, with budget proposals to the Office of Management and Budget, a statement certifying consistency of proposed projects and programs with approved regional plans.

The Comprehensive Coordinated Joint Plan, Plan of Study indicates that all plan products will be consistent with the plan formulation statements in the Water Resources Council's "Principles and Standards for Planning Water and Related Land Resources" (P&S). The P&S provide the basis for federal participation with river basin commissions, states, and others in the preparation, formulation, evaluation, review and revision, and final transmittal to Congress of plans

for states, regions, and river basins (see Appendix D). To comply with P&S requirements, alternative solutions in the Water Resources Management Plan are evaluated according to their optimum contributions to the National Economic Development (NED) and Environmental Quality (EQ) planning objectives. In addition, the beneficial and adverse effects of these alternative solutions are discussed and displayed utilizing the four-account system: National Economic Development (NED), Environmental Quality (EQ), Regional Economic Development (RED), and Other Social Effects (OSE). Each alternative solution is analyzed according to the components of each of the four-accounts (see Appendix E).

Beginning in December 1979 and with the April 1980 edition, a revision of the P&S was proposed to accomplish the full integration of water conservation into project and program planning and review as a means of achieving both the NED and the EQ objectives, and to require the preparation and inclusion of a primarily nonstructural plan as one alternative whenever structural project or program alternatives are considered. Additional changes were proposed for the P&S to assure consistency with the procedures for national economic development benefit and cost evaluation. In this plan all financial figures or project costs are in 1980 dollars unless specified.[1]

This document is the current plan for the development, management, and conservation of the Upper Mississippi Region's water and related land resources. The analysis through 2000 is divided into nine functional areas of water and related land resources: water supply, water quality, erosion and sedimentation, flood damage, water recreation, fish and wildlife, commercial navigation, energy, and instream flows.

The Water Resources Management Plan, Volume I: Upper Mississippi Region, is a technical document which analyzes water resources problems into three parts. Part I provides background information and projections for the discussion and analysis of problems in Part 2. Both a federal projection system (OBERS "E"--1972) and an aggregated state projections system (OBERS "E"--States) were used to provide the basis for the discussion of "Current Conditions and Problems" and "Anticipated Problems" in Part II. Part III is the conclusion of the plan where specific regional policies and recommendations are listed.

Since this plan is regional, emphasis is directed toward broader interstate problems and issues. For a detailed analysis of each of the fourteen river basins, consult the Water Resources Management Plan, Volume II. Upper Mississippi Subregions (Nos. 1-14). For a discussion of methodology and procedure in preparing the regional and subregional plans, consult the Water Resources Management Plan, Volume III Reference Handbook.

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[1]In all applicable cases, costs were converted to 1980 dollars using the following Consumer Price Index inflator values: 1967-100 (base year); 1968-104.2; 1969-109.8; 1970-116.3; 1971-121.3; 1972-125.3; 1973-133.1; 1974-147.7; 1975-161.2; 1976-170.5; 1977-181.5; 1978-195.3; 1979-217.7; 1980-244.0. U.S. Department of Commerce, personal communication, 25 April 1980.

GOALS AND PLANNING OBJECTIVES

Goal

The formulation of goals and objectives reflecting society's preferences for the management, conservation, and use of water and land resources provides for the consideration of alternative courses of action for attaining these preferences. In February 1974, the Upper Mississippi River Basin Commission through its Goals, Objectives, and Policies Committee developed a comprehensive set of goals and objectives for the use of the region's resources:

> The goal of the Upper Mississippi River Basin Commission is to maintain and enhance the physical and social environment of the Upper Mississippi River Basin consistent with the physical and social needs of the Basin's citizens.

More precisely, the Upper Mississippi River Basin Commission will strive to:

(1) maximize the beneficial effects of opportunities related to water and related land resources;

(2) resolve regional conflicts among water and related land uses and among regional institutional entities;

(3) identify and solve water and related land resource problems; and

(4) improve the institutional arrangements and abilities necessary to the successful accomplishment of the above goals, and necessary or useful to individual members in solving regional problems.

These goals represent the specific aspirations society has for its social, economic, and environmental well-being. In many cases, these goals approach the ideal condition and are not necessarily attainable.

State and Regional Planning Objectives

Resolving immediate and mid-term problems and needs through Commission policy are interim objectives prior to fulfilling the goal of the Commission. Objectives may be functional, institutional, or legal. These objectives provide the basis for the development of the Water Resources Management Plan. The original objectives were developed as part of the "First-Cut Comprehensive Coordinated Joint Plan" in September 1977 but modified through the planning process. These final objectives are being adopted through this report.

Water Supply

- to develop and manage water resources for assuring an adequate supply for domestic, municipal, industrial, agricultural, fish and wildlife, recreation, power, and navigation purposes from surface or groundwater resources
- to identify water supply alternatives and implement water quality standards that will protect the public health
- to promote a water conservation strategy that improves water use efficiency

Water Quality

- to improve the chemical, physical, and biological integrity of the region's water resources to protect public health, safeguard fish and aquatic life as well as scenic and ecological values, and provide better quality water supplies for domestic, municipal, recreational, industrial, and agricultural water uses; to maintain future water quality levels in accordance with existing state and federal policies and regulations which are designed to meet the goals of the 1977 Clean Water Act

- to improve programs for the control of municipal and industrial waste discharges and make improvements in land management and conservation practices for the control of non-point source pollution

- to encourage waste treatment, rather than low-flow augmentation, for controlling pollution and to recognize that, under certain circumstances, flow stabilization may be a necessary part of a pollution abatement program, especially where nonpoint sources are major contributors of pollution

Erosion and Sedimentation; Food and Fiber Production

- to protect soil resources by preventing adverse land uses and reducing off-site damage from wind and water-carried soil materials, and specifically:
  - to reduce erosion rates within acceptable limits,
  - to protect all soils from irreversible damage which will render them less fit for plant growth and absorption of precipitation,
  - to give high priority to the protection of fragile soils with a high crop production potential,
  - to encourage the development of erosion control ordinances which minimize soil loss during periods of construction and development, and
  - to promote the adoption and enforcement of those land use practices which will minimize soil degradation and off-site damages
- to minimize the adverse effects of erosion and sedimentation on the quality of lakes and reservoirs through encouragement of land treatment and conservation practices
- to expand agricultural and forestry production as national and foreign demands for food and fiber products increase, while still protecting the environment from excessive soil loss and pollution from wastes and chemicals
- to discourage the conversion of prime agricultural and forest land to urban and residential uses
- to permit development of surface water and groundwater irrigation facilities where there will be no interference with surrounding water users or damage to aquatic resources, and in special cases to permit the diversion of surface water for irrigation purposes

Flood Damage

- to reduce flood damages by promoting initial consideration of programs that stress nonstructural measures, such as floodplain zoning, flood-proofing, and forecasting techniques for flood, water supply, and streamflow
- to promote the coordination of individual state floodplain management and regulation programs, particularly along the main stem of the Mississippi River

Water Recreation

- to assure a quality and sufficient resource heritage (land, water, and human resources) that meets present and future public requirements, and to provide the highest standards for the identification, selection, preservation, development, management, and use of these resources
- to accelerate through private and public means the protection and preservation of wild and scenic rivers, recreational rivers, scientific and natural areas, wildlife management areas, prime wetland areas, floodplains, and natural, historical, and archaeological resources

- to provide adequate recreational facilities and environmental resources in and near urban areas as well as those portions of the region characterized by limited recreational and environmental resources

Fish and Wildlife; Instream Flows

- to preserve, protect, and manage valuable natural habitat areas of threatened and endangered species of plants, wildlife, and fish

- to preserve valuable fish and wildlife habitat and the recreational and aesthetic qualities of streams by maintaining a recommended minimum instream flow

- to strengthen and improve legal and institutional arrangements designed to identify and describe wetland resources and to preserve these resources in accordance with established environmental and economic objectives

- to encourage state and federal natural resource agencies to develop their management plans cooperatively and to implement their management programs so that the Upper Mississippi River is managed as an ecological unit

- to consider aesthetics as part of any management plan for the Mississippi River

Navigation

- to encourage the development of a transportation system which utilizes all modes of transportation including rail, highway, waterway, air, and pipeline that will meet the area's transportation needs in the most economical and efficient manner with a minimum of adverse and irreversible damage to valuable natural resources

- to develop a total river resource management plan for the Mississippi River

Energy

- to encourage development of traditional energy resources but to also encourage the investigation and use of alternative sources such as solar energy, geothermal energy, and coal gasification in order to meet energy demand while maintaining water and land resources

- to promote energy conservation including the use of energy efficient systems and reduction of peak power consumption which will reduce demand and minimize environmental effects

- to site electric power generating facilities compatible with environmental standards and efficient use of resources

- to assure that environmental standards for air, water quality, and waste disposal be not eliminated or relaxed in favor of short-term gains in alternate fuel use and supplies

PART 1

THE REGION: PRESENT AND FUTURE

PHYSICAL SETTING

The Upper Mississippi Region, one of the 21 water resource regions defined by the U.S. Water Resources Council, is in the Middle West of the United States and contains major portions of Illinois, Iowa, Minnesota, Missouri, Wisconsin, and small portions of Indiana, South Dakota, and Michigan (Table I-1). The watershed area of the region is 189,000 square miles and extends from the headwaters of the Mississippi River in north-central Minnesota downstream in a north-south direction for some 700 airline miles to the mouth of the Ohio River. The region is subdivided into fourteen plan areas that are generally based on the major hydrologic river basins (Figure I-1). River basins range in size from the 4600 square mile St. Croix River Basin to the Iowa-Skunk-Wapsipinicon at 24,500 square miles. Land and water resources differ among and within these river basins from the physical processes that initially shaped them and from the effects of resource utilization.

The region lies mostly within the Central Lowland physiographic province except in the north where the headwaters drain a portion of the Superior Upland and in the south where a few streams originate in the Ozark Plateau. Topography has been shaped primarily through glaciation. Glaciers modified the landscape throughout the region except in southwest Wisconsin, northeast Iowa, and northwest Illinois, known as the Driftless Area, and in the extreme southern part of the region. These two areas are extensively dissected by streams, creating numerous escarpments and bluffs, while the remainder of the region is gently rolling terrain. Natural lakes are prevalent throughout the region but prominent in central and northern Minnesota and northwestern Wisconsin, reflecting the glaciated history of the area. Thousands of lakes characterize this drift-covered Precambrian surface.

TABLE I-1. LAND CHARACTERISTICS[a], UPPER MISSISSIPPI REGION

	AREA (acres)					
				Land		Federal
	TOTAL	LAND	WATER	Urban	Rural	Land
Upper Mississippi Region	119,004,960	116,263,467	2,741,473	4,988,075	111,275,382	2,171,282
Subregions						
Mississippi Headwaters	14,317,600	13,254,205	1,063,395	776,005	12,478,200	681,717
Minnesota	10,356,480	10,104,320	252,160	134,440	9,969,880	60,154
St. Croix	2,989,440	2,888,643	100,797	33,661	2,854,982	13,275
Black-Root	7,088,000	7,006,275	81,725	157,958	6,848,317	110,354
Chippewa	5,275,520	5,130,614	144,906	99,163	5,031,451	390,818
Maquoketa-Plum	4,787,200	4,696,742	90,458	103,081	4,593,661	50,941
Wisconsin	7,376,000	7,077,427	298,573	192,199	6,885,228	162,766
Iowa-Skunk-Wapsipinicon	15,766,400	15,647,170	119,230	452,625	15,194,545	61,394
Rock	6,179,840	6,106,356	73,484	376,316	5,730,040	23,373
Des Moines	9,841,280	9,771,670	69,610	192,124	9,579,546	62,415
Salt-Sny	5,902,720	5,817,572	85,148	79,890	5,737,682	85,731
Upper Illinois	5,934,080	5,886,578	47,502	1,261,608	4,624,970	42,292
Lower Illinois	11,135,360	11,022,395	112,965	438,666	10,583,729	9,859
Kaskaskia-Meramec	12,055,040	11,853,520	201,520	684,277	11,169,243	416,193
State Portions						
Illinois	28,979,840	28,563,608	416,232	2,241,611	26,321,997	305,884
Indiana	1,213,440	1,207,460	5,980	93,718	1,113,742	940
Iowa	25,319,680	25,165,032	154,648	592,480	24,572,552	133,941
Minnesota	29,561,760	28,189,519	1,372,241	1,026,307	27,163,212	773,327
Missouri	9,644,800	9,550,458	94,342	396,030	9,154,428	282,692
South Dakota	1,169,920	1,144,960	24,960	6,674	1,138,286	6,232
Wisconsin	23,115,520	22,442,450	673,070	631,255	21,811,195	668,266

[a]Data for land and socio-economic characteristics; domestic, manufacturing, mining, irrigation, livestock, and energy water use; recreation; and fish and waterfowl hunting were collected and analyzed exclusively by counties and organized by "Water Resources Subareas" (River basins approximated by county boundaries--U.S. Water Resources Council, 1977). A "Water Resources Subarea" will be always referred to as "Subregion". See Reference Handbook for additional information.

Source: U.S. Department of Agriculture, Soil Conservation Service, 1977 National Resources Inventory, 1979. (unpublished data)

FIGURE I-1. THE UPPER MISSISSIPPI RIVER BASIN

Sources: Base map after U.S. Geological Survey, *U.S. 1:250,000*, 1972.
Subregion boundary from U.S. Geological Survey, *Hydrologic Unit Maps – 1974; Illinois*, 1975; *Indiana*, 1974; *Iowa*, 1976; *Minnesota*, 1976; *Missouri*, 1977; *South Dakota*, 1976; *Wisconsin*, 1975.

Soils formed through glaciation are agriculturally productive. Glacial drift, which covers most of the region, is often covered by loess (windblown silt). These soils are suited for intensive cropping with only a few limitations which reduce the choice of plants and require conservation practices. Soils not suited for cultivation are mostly used for pasture, woodland, and food and cover areas for wildlife. In the north and south soil conditions limit agricultural use.

The natural vegetation of the region consisted primarily of forests in the north and south, grasses in the east and west, and an intermingling of grasses and forests in the central portions. Most native prairie has been converted to cropland and pasture.

Climate

Climate within the Upper Mississippi Region is humid continental. The average annual precipitation varies from 20 inches in the north to 48 inches in the south (Figure I-3). The north receives most precipitation in the summer while the south has a more even seasonal distribution. Runoff is least in the west and greatest in the south. Average annual temperatures range from 39°F in the north to 60°F in the south. Winters are severe in the north, with subzero temperatures common. Frost-free periods vary from 90 days in the northeast to 210 days in the extreme south.

The climate is amenable to agriculture. The fertile cropland areas generally receive ample precipitation with sandy soils requiring most irrigation. In addition, the duration of the frost-free period seldom limits crop production. Conditions of moderate to severe droughts will affect agriculture at least once in five to six years except in the west where they occur more frequently. Severe droughts tend to persist or recur several years in succession. Thunderstorms frequently cause crop damage throughout the region.

Mineral Resources

Principal mineral resources in the region include coal, iron ore, petroleum, lead, zinc, dimension stone, crushed stone, and sand and gravel. Some resources are regional while others are only local. Large concentrations of coal are in the south, mainly in central and southern Illinois, and minor amounts in Iowa and Missouri (Figure I-2). Petroleum is confined entirely to southern Illinois. Major iron ore deposits are concentrated in narrow belts in Minnesota with lesser amounts in Wisconsin and Missouri. Lead and zinc are found in southwestern Wisconsin and in Missouri. Dimension stone processing is concentrated especially in central Minnesota, southeastern Wisconsin, southern Missouri, and in Illinois. Sand and gravel and crushed stone are found throughout and usually quarried near the market. Other mineral production, such as copper, nickel, and uranium mining in

FIGURE I-2. MAJOR MINERAL DEPOSITS, UPPER MISSISSIPPI REGION

Sources: U.S. Geological Survey, *Coal Fields of the United States*, by James Trumbull, 1960. (map)
U.S. Geological Survey, *Iron in the United States*, 1967.
U.S. Geological Survey, *Lead in the United States*, 1962.
U.S. Geological Survey, *Zinc in the United States*, 1962.

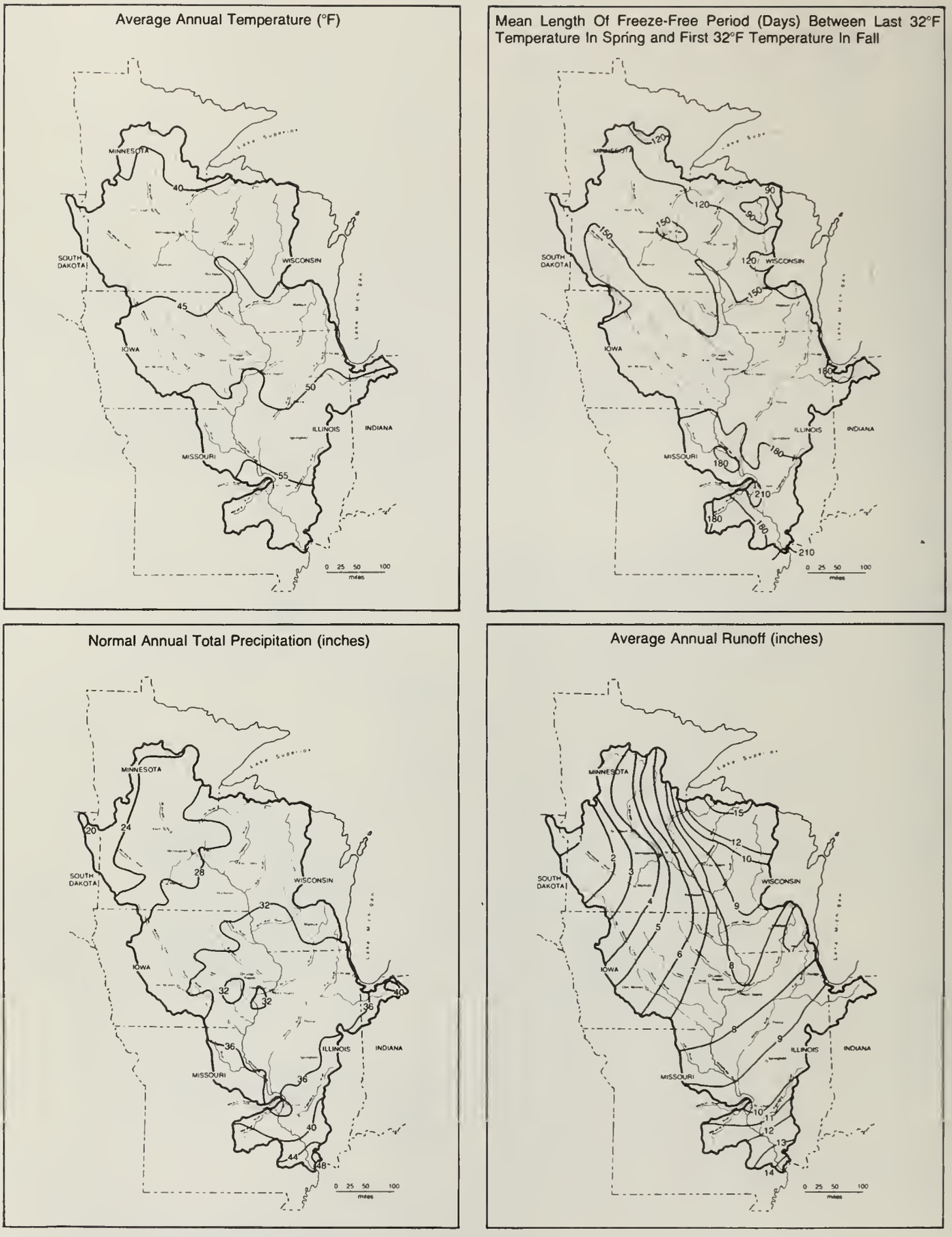

FIGURE I-3. CLIMATIC DATA AND RUNOFF, UPPER MISSISSIPPI REGION

Source: UMRCBS Coordinating Committee, *Upper Mississippi River Comprehensive Basin Study*, (Vol. II), 1970.

northern Minnesota, may be economically and technologically possible in the future.

Wildlife and Recreation Resources

Before European settlement, the Upper Mississippi Region contained vast forests, wetlands, and prairies which supported a varied wildlife population. Following settlement, forests were cleared and wetlands were drained for agriculture and development. Although wetland drainage continues, many of the large, valuable wetlands have been protected in state and federal wildlife areas (Figure I-4). Wetlands of value for waterfowl are concentrated in the north and along major rivers (Figure I-5). Over 114,000 acres of these wetlands have been protected for waterfowl nesting in Waterfowl Production Areas. These areas are concentrated in southwestern Minnesota and central Wisconsin.

National Wildlife Refuges were originally established to protect important waterfowl nesting and resting areas along the Mississippi Flyway (Table I-2). These have been expanded to include habitat for many other kinds of wildlife including songbirds, colonial nesting birds, furbearers, and several endangered species such as the bald eagle and peregrine falcon.

A greater amount of wildlife habitat is protected in state wildlife areas, which are most numerous in Minnesota and Wisconsin (Table I-3). These states also contain the greatest number of natural lakes, providing excellent habitat for a variety of gamefish. In Iowa, Illinois, and Missouri, state wildlife areas are often associated with large reservoirs or major rivers, which also provide the majority of water related recreation opportunities.

State parks are evenly distributed throughout the region but are more numerous along major rivers (Figure I-6). State forests provide wildlife habitat

TABLE I-2. NATIONAL WILDLIFE REFUGES, UPPER MISSISSIPPI REGION

Refuge	Acreage[a]
ILLINOIS	39,655
Chataqua	5,125
Crab Orchard	44,000[b]
Mark Twain	15,256
Meredosia	1,850
Upper Mississippi River	23,424[c]
IOWA	57,357
Mark Twain	4,366
Union Slough	2,200
Upper Mississippi River	50,791[c]
MINNESOTA	97,718
Big Stone	10,794
Mille Lacs	1
Minnesota Valley	3,164[d]
Rice Lake	20,297
Sandstone	2240
Sherburne	30,479
Upper Mississippi River	32,983[c]
MISSOURI	3,889
Clarence Cannon	3,747
Mark Twain	142
WISCONSIN	152,944
Horicon	20,976
Necedah	39,549
Trempaleau	5,617
Upper Mississippi River	86,802
UPPER MISSISSIPPI REGION	401,563

[a]Total acreage comprises: reserved from public domain, acquired by other federal agency, devise or gift, purchase, easement, or lease
[b]Approximate figure
[c]Acreage for the Upper Mississippi River Wild Life and Fish Refuge includes lands under the primary control of the U.S. Army Corps of Engineers
[d]Acreage as of December 31, 1980. Proposed acreage is 9500.

Sources: U.S. Department of the Interior, Division of Realty, Annual Report of Lands Under Control of the U.S. Fish and Wildlife Service as of September 30, 1979.

Personal Communication with the U.S. Fish and Wildlife Service, March 1981.

TABLE I-3. STATE WILDLIFE AREAS[a], UPPER MISSISSIPPI REGION

	Acreage
Illinois	122,351
Indiana	31,569
Iowa	145,796
Minnesota	310,448
Missouri	68,403
South Dakota	5,472
Wisconsin	489,027
UPPER MISSISSIPPI REGION	1,173,066

[a]Includes areas owned (or leased) and managed by states primarily for wildlife. Also includes areas owned by federal agencies and managed by states (cooperative agreement lands). Does not include state forests, state parks, state preserves, natural areas, or access and tower sites. Many excluded areas are managed for wildlife or are open to wildlife related recreation, but are not managed principally for wildlife.

Sources: Illinois Department of Conservation, Recreation Areas, 1978
Indiana Department of Natural Resources, Property Report, 1979
Iowa Conservation Commission, Iowa Public Hunting Areas, n.d.
Minnesota Department of Natural Resources, Minnesota Wildlife Lands 1978-1979. (map)
Missouri Department of Conservation, State and Federal Lands in Missouri, June 1979. (map)
Missouri Department of Conservation, Engineering Section, Land Records, July 1979.
South Dakota Department of Game, Fish, and Parks, Guide to State Public Shooting Areas and Federal Waterfowl Production Areas, n.d.
Wisconsin Department of Natural Resources, Public Lands Open to Hunting, 1979

STATE AND FEDERAL WILDLIFE AREAS (Numbers correspond to FIGURE I-4)

NATIONAL WILOLIFE REFUGES

		acres
A.	Big Stone	10,794
B.	Rice Lake	20,297
C.	Mille Lacs	1
O.	Sandstone	2,240
E.	Sherburne	30,479
F.	Minnesota Valley	3,154
G.	Trempealeau	5,617
H.	Necedah	39,549
I.	Horicon	20,976
J.	Upper Mississippi River	194,000
K.	Union Slough	2,200
L.	Chatauqua	5,125
M.	Mark Twin	19,764
N.	Meredosia	1,850
O.	Clarence Cannon	3,747
P.	Crab Orchard	44,000

WATERFOWL PRODUCTION AREAS

	acres
Iowa	214
Minnesota	84,005
South Dakota	23,120
Wisconsin	6,721

STATE WILOLIFE AREAS (over 2,000 acres)

MINNESOTA

		acres
1.	Morph Meadows Wildlife Management Area (WMA)	5,280
2.	Mud-Goose WMA	10,946
3.	Crow Wing Chain WMA	3,070
4.	Smoky Hollow WMA	5,680
5.	Moose-Willow WMA	15,580
6.	Ripple River WMA	5,138
7.	Kimberly WMA	9,833
8.	Grayling WMA	6,157
9.	Mille Lacs WMA	38,165
10.	Lac Qui Parle WMA	26,615
11.	Carlos Avery WMA	22,852
12.	Gores Pool WMA	6,174
13.	Talcot Lake WMA	3,279
14.	Whitewater WMA	25,497

IOWA

		acres
66.	Brushy Creek Public Hunting Area (PHA)	2,000
67.	Big Marsh PHA	2,813
68.	Volga River PHA	3,000
69.	Otter Creek Marsh PHA	3,360
70.	Red Rock PHA	25,542
71.	Hawkeye PHA	14,000
72.	Green Island PHA	2,722
73.	Lake Odessa PHA	4,179
74.	Mississippi River Wildlife Area*	4,646

MISSOURI

		acres
75.	Deer Ridge Wildlife Area (WA)	4,632
76.	Ted Shanks Memorial WA*	3,957
77.	Upper Mississippi River WA*	11,000
78.	August A. Busch Memorial WA	6,987
79.	Woodson K. Woods Memorial WA	5,581
80.	Huzzah WA	6,162

ILLINOIS

		acres
81.	Mississippi River Fish and Waterfowl Area*	23,765
82.	Sanganois Conservation Area (CA)	8,613
83.	Anderson Lake CA	2,133
84.	Rice Lake CA	2,640
85.	Woodford County CA	2,900
86.	Marshall County CA	3,122
87.	Lake Oe Pue CA	2,041
88.	Lee County CA	2,330
89.	Des Plaines CA	4,253
90.	Shelbyville Wildlife Management Area	6,231
91.	Carlyle Game Management Area	15,870
92.	Baldwin Lake CA	8,234
93.	Rend Lake Game Management Area	16,264
94.	Union County CA	6,202
95.	Horseshoe Lake CA	7,901

INDIANA

		acres
96.	LaSalle Fish and Wildlife Area (FWA)	3,551
97.	Willow Slough FWA	9,344
98.	Jasper-Pulaski FWA	7,585
99.	Winamac FWA	4,292
100.	Kankakee FWA	2,299
101.	Kingsbury FWA	4,498

* Area includes cooperative agreement lands. These lands are normally owned by federal agencies but managed by the states.

WISCONSIN

		acres
15.	Douglas County Public Hunting Grounds (PHG)	3,200
15.	Namekagon Barrens PHG	5,587
17.	Totogatic River PHG	2,719
18.	Fish Lake PHG	12,953
19.	Crex Meadows PHG	26,563
20.	Amsterdam Sloughs PHG	5,582
21.	McKenzie Creek PHG	5,217
22.	Rice Beds Creek PHG	2,675
23.	Meirgor Springs PHG	2,050
24.	Kimberly Clark PHG	7,670
25.	Hay Creek-Hoffman Lake PHG	10,600
26.	Powell Marsh PHG	11,828
27.	Thunder Lake PHG	2,070
28.	Tiffany PHG	11,000
29.	Dunnville PHG	3,051
30.	Muddy Creek PHG	4,771
31.	Jim Falls PHG	2,804
32.	Augusta PHG	3,278
33.	Pershing PHG	7,097
34.	Ackley PHG	2,143
35.	McMillan Marsh PHG	5,674
36.	Mead PHG	27,240
37.	Dewey Marsh PHG	3,706
38.	Van Loon PHG	4,300
39.	Bangor PHG	5,500
40.	Meadow Valley PHG	56,480
41.	Wood County PHG	19,303
42.	Sandhill PHG	9,455
43.	Colburn PHG	4,849
44.	Kickapoo River PHG	6,668
45.	Wauzeka PHG	4,108
46.	Woodman-Millville PHG	3,950
47.	Blue River PHG	4,378
48.	Knapp Creek PHG	4,182
49.	Pine River PHG	2,863
50.	Avoca PHG	4,687
51.	Witwen PHG	2,393
52.	Mazomanie PHG	5,451
53.	Pine Island PHG	4,822
54.	Deansville PHG	2,318
55.	Waterloo PHG	6,174
56.	Mud Lake PHG	4,365
57.	Horicon Marsh PHG	10,962
58.	Theresa PHG	5,443
59.	New Glarus PHG	3,255
60.	Albany PHG	2,345
61.	Footville PHG	9,117
62.	Lima Marsh PHG	2,713
63.	Princess Point PHG	2,186
64.	Vernon PHG	3,788
65.	Bong PHG	4,764

FIGURE I-4. STATE** AND FEDERAL WILDLIFE AREAS, UPPER MISSISSIPPI REGION

Areas ≥ 2000 acres in which the **principal activity is wildlife-oriented e.g., wildlife management for hunting; protection of nesting, feeding, and resting areas; propagation areas for nongame species; or observation and study of game and nongame species.

Sources: Illinois Department of Conservation, *Recreational Areas,* 1978.
Iowa Conservation Commission, *Iowa Public Hunting Areas,* n.d.
Minnesota Department of Natural Resources, Division of Fish and Wildlife, *Minnesota Wildlife Lands 1978-1979.* (map)
Missouri Department of Conservation, *State and Federal Lands in Missouri,* June 1979. (map)
Wisconsin Department of Natural Resources, *Public Lands Open to Hunting,* 1979.
State highway map for Illinois, Indiana, Iowa, Minnesota, Missouri, South Dakota, Wisconsin, 1980.
Personal communication with the U.S. Fish and Wildlife Service, 1980 and 1981.
Migratory Bird Conservation Commission, *Report for Fiscal Year Ended September 30, 1980,* November 1980.

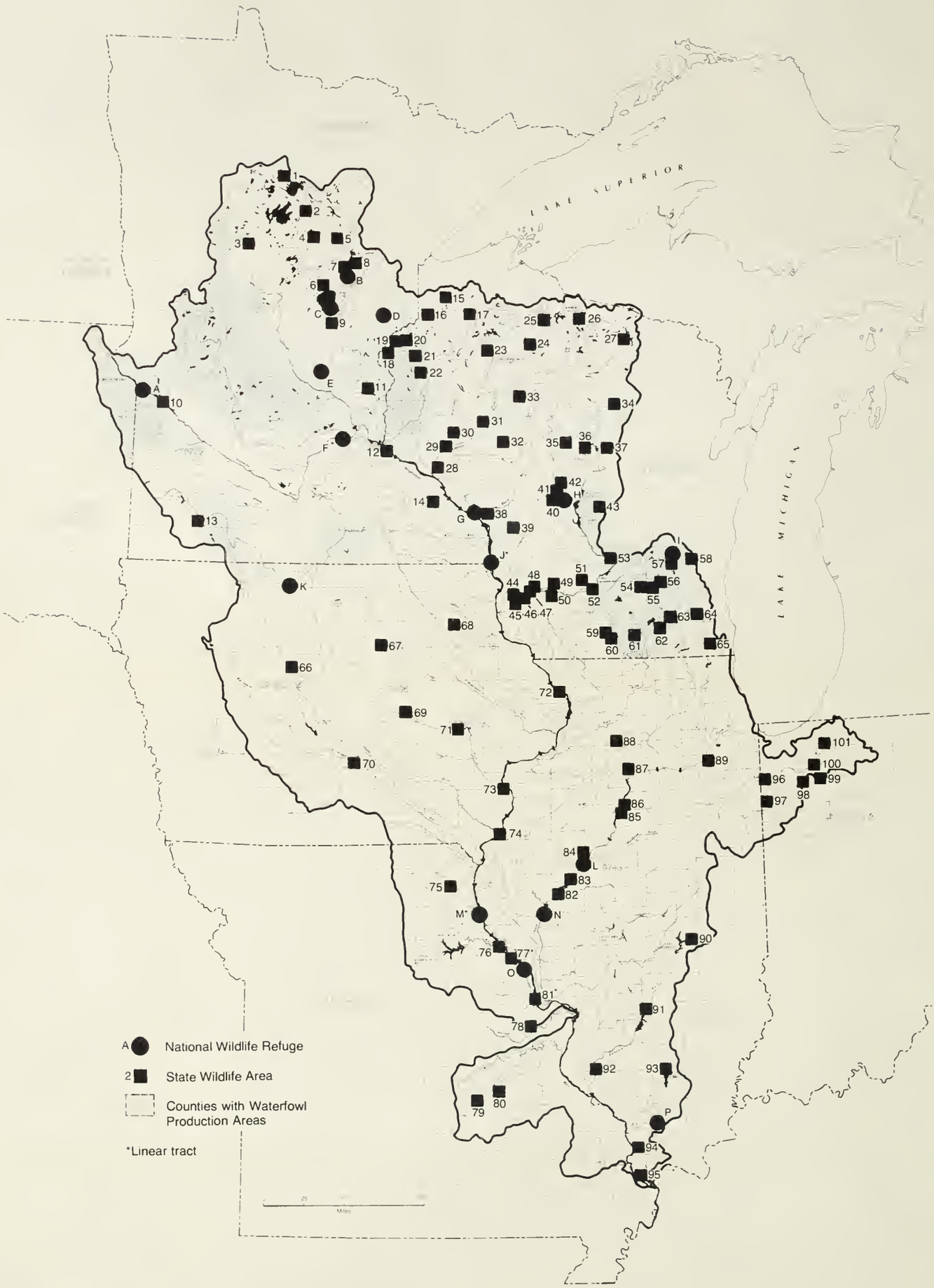

FIGURE I-4. STATE** AND FEDERAL WILDLIFE AREAS, UPPER MISSISSIPPI REGION

Areas ≥ 2000 acres in which the **principal activity is wildlife-oriented e.g., wildlife management for hunting; protection of nesting, feeding, and resting areas; propagation areas for nongame species; or observation and study of game and nongame species.

Sources: Illinois Department of Conservation, *Recreational Areas*, 1978.
Iowa Conservation Commission, *Iowa Public Hunting Areas*, n.d.
Minnesota Department of Natural Resources, Division of Fish and Wildlife, *Minnesota Wildlife Lands 1978-1979*. (map)
Missouri Department of Conservation, *State and Federal Lands in Missouri*, June 1979. (map)
Wisconsin Department of Natural Resources, *Public Lands Open to Hunting*, 1979.
State highway map for Illinois, Indiana, Iowa, Minnesota, Missouri, South Dakota, Wisconsin, 1980.
Personal communication with the U.S. Fish and Wildlife Service, 1980 and 1981.
Migratory Bird Conservation Commission, *Report for Fiscal Year Ended September 30, 1980*, November 1980.

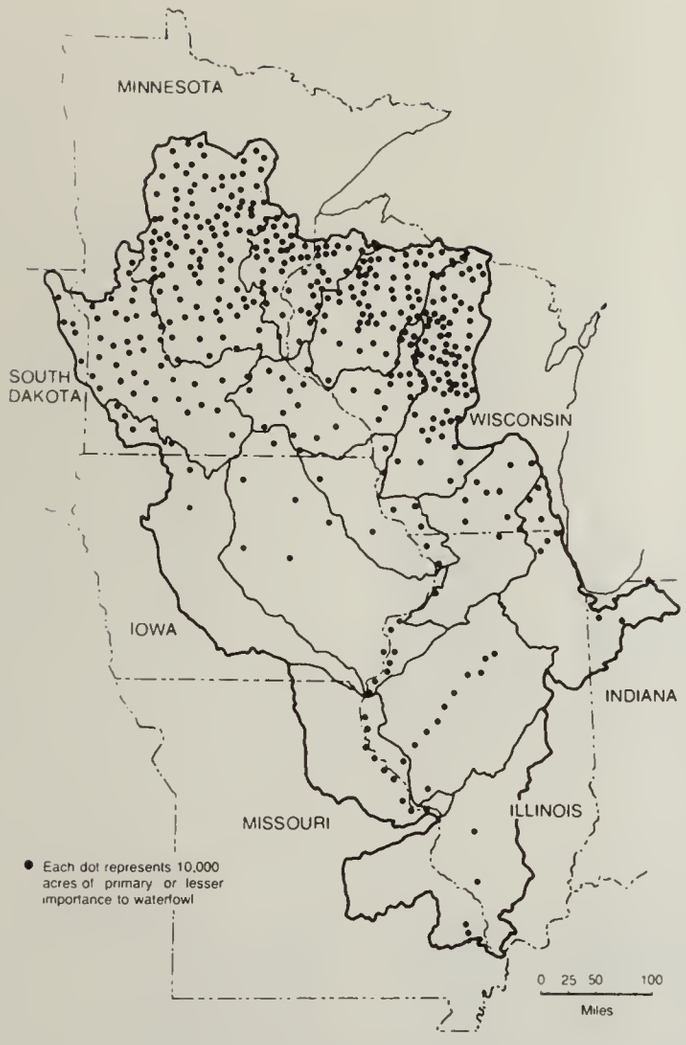

FIGURE I-5. WETLANDS VALUABLE FOR WATERFOWL — 1955, UPPER MISSISSIPPI REGION

Source: U.S. Department of the Interior, U.S. Fish and Wildlife Service, *Wetlands of the United States*, circular 39, 1971.

and recreation opportunities and are concentrated in the extreme northern and southern portions of the region. Several linear tracts (rivers and trails) and sites (natural landmarks and historic places) are afforded stricter protection because of their cultural, historical, and aesthetic values (Figure I-7). Included in the linear tracts is the lower portion of the St. Croix River which was among the first designated National Wild and Scenic Rivers. Also nationally significant are the Ice Age Trail and the Ice Age National Scientific Reserves in Wisconsin. Of the federal sites designated in the region, the majority of which are in Illinois and Wisconsin, 30 are National Natural Landmarks and 1527 are National Historic Places.[2]

Water Resources

Water resources in the Upper Mississippi Region are generally abundant and of better quality than other areas in the United States. The most prominent water resources features are the Mississippi River and its major tributaries, and the numerous large lakes of glacial origin in the north. These surface water resources serve municipal, industrial, and agricultural needs while, in most instances, still providing a suitable environment for recreation, fish, and wildlife. Groundwater resources are also extensively used, particularly the alluvial aquifers along major streams and the bedrock aquifers in the north. Large supplies of potable groundwater are stored in these and other aquifers.

Surface Water

Surface water supports most current offstream uses and provides ample resources for fish and wildlife propagation and recreation activities. The Mississippi

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[2]Before 1979, National Historic Places designated in the region (aggregated subareas) totaled 1,317--363 in the Illinois portion, 8 in the Indiana portion, 294 in the Iowa portion, 333 in the Minnesota portion, 108 in the Missouri portion, 6 in the South Dakota portion, and 205 in the Wisconsin portion; U.S. Department of the Interior, Heritage Conservation and Recreation Service, "National Register of Historic Places: Annual Listing of Historic Properties," Federal Register Volume 44 No. 26 part II, (6 February 1979), pp. 7415-7649. In 1979, an additional 210 properties were designated--88 in the Illinois portion, 49 in the Iowa portion, 22 in the Minnesota portion, 10 in the Missouri portion, and 41 in the Wisconsin portion; U.S. Department of the Interior, Heritage Conservation and Recreation Service, "National Register of Historic Places: Annual Listing of Historic Properties," Federal Register Volume 45 No. 54 part II, (18 March 1980), pp. 17446-17519.

STATE PARKS AND FORESTS (Numbers correspond to FIGURE I-6)

STATE PARKS

SOUTH DAKOTA

1. Hartford Beach (0702)

MINNESOTA

2. Itasca (0701)
3. Lake Bemidji (0701)
4. Schoolcraft (0701)
5. Savanna Portage (0701)
6. Moose Lake (0703)
7. Banning (0703)
8. St. Croix (0703)
9. Father Hennepin (0701)
10. Mille Lacs Kathio (0701)
11. Crow Wing (0701)
12. Charles A. Lindbergh (0701)
13. Lake Carlos (0701)
14. Big Stone Lake (0702)
15. Glacial Lake (0702)
16. Monson Lake (0702)
17. Sibley (0701, 0702)
18. Lake Maria (0701)
19. St. Croix Wild River (0703)
20. Interstate (0703)
21. William O'Brien (0703)
22. Fort Snelling (0702)
23. Afton (0703)
24. Frontenac (0704)
25. Carley (0704)
26. Whitewater (0704)
27. O. L. Kipp (0704)
28. Beaver Creek Valley (0704)
29. Forestville (0704)
30. Lake Louise (0706)
31. Helmer Myre (0708)
32. Rice Lake (0704)
33. Nerstrand Woods (0704)
34. Sakatah Lake (0704)
35. Minneopa (0702)
36. Flandrau (0702)
37. Fort Ridgely (0702)
38. Upper Sioux Agency (0702)
39. Lac Qui Parle (0702)
40. Camden (0702)
41. Lake Shetek (0710)
42. Kilen Woods (0710)

WISCONSIN

43. Lucius Woods (0703)
44. Ojibwa (0705)
45. Interstate (0703)
46. Willow River (0703)
47. Lake Wissota (0705)
48. Brunet Island (0705)
49. Council Grounds (0707)
50. Rib Mountain (0707)
51. Merrick (0704)
52. Perrot (0704)
53. Wildcat Mountain (0707)
54. Mill Bluff (0707)
55. Buckhorn (0707)
56. Roche A Cri (0707)
57. Rocky Arbor (0707)
58. Mirror Lake (0707)
59. Devil's Lake (0707)
60. Natural Bridge (0707)
61. Tower Hill (0707)
62. Wyalusing (0707)
63. Governor Dodge (0707)
64. Blue Mounds (0707)
65. Lake Kegonsa (0709)
66. Aztalan (0709)
67. Pike Lake (0709)
68. Cushing Memorial (0709)
69. New Glarus Woods (0709)
70. Yellowstone Lake (0709)
71. First Capitol (0706)
72. Nelson Dewey (0706)
73. Cadiz Springs (0709)
74. Big Foot Beach (0712)

IOWA

75. Fort Defiance (0710)
76. Okamanpedan (0710)
77. A. A. Call (0710)
78. Rice Lake (0708)
79. Pilot Knob (0708)
80. McIntosh Woods (0708)
81. Clear Lake (0708)
82. Beeds Lake (0708)
83. Volga River (0706)
84. Echo Valley (0706)
85. Pikes Peak (0706)
86. Backbone (0706)
87. George Wyth Memorial (0708)
88. Pine Lake (0708)
89. Brushy Creek (0710)
90. Dolliver Memorial (0710)
91. Twin Lakes (0710)
92. Black Hawk Lake (0710)
93. Springbrook (0710)
94. Ledges (0710)
95. Big Creek (0710)
96. Rock Creek (0708)
97. Union Grove (0708)
98. Pleasant Creek (0708)
99. Bellvue (0706)
100. Maquoketa Cave (0706)
101. Wapsipinicon (0708)
102. Palisades Kepler (0708)
103. Lake Macbride (0708)
104. Wild Cat Den (0708)
105. Fairport (0708)
106. Lake Darling (0708)
107. Lake Keomah (0708)
108. Elk Rock (0710)
109. Walnut Woods (0710)
110. Badger Creek (0710)
111. Pammel (0710)
112. Lake Ahquabi (0710)
113. Wilcox (0710)
114. Red Haw Lake (0710)
115. Lake Wapello (0710)
116. Lacey Keosaqua (0710)
117. Geode (0708)

ILLINOIS

118. Apple River Canyon (0706)
119. Lake Le-Aqua-Na (0709)
120. Rock Cut (0709)
121. Chain O'Lakes (0712)
122. Moraine Hills (0712)
123. Lowden (0709)
124. Castle Rock (0709)
125. White Pines Forest (0709)
126. Mississippi Palisades (0706)
127. Morrison Rockwood (0709)
128. Prophetstown (0709)
129. Johnson Sauk Trail (0709)
130. Hennepin Canal Parkway (0709)
131. Matthiessen (0713)
132. Starved Rock (0713)
133. Buffalo Rock (0713)
134. Illini (0713)
135. Silver Springs (0712)
136. Gebhard Woods (0712)
137. William G. Stratton (0712)
138. Illinois and Michigan Canal (0712)
139. Goose Lake Prairie (0712)
140. Kankakee River (0712)
141. Creve Coeur (0713)
142. Jubilee College (0713)
143. Delabar (0708)
144. Argyle Lake (0713)
145. Weinberg-King (0713)
146. Siloam Springs (0713)
147. Railsplitter (0713)
148. Weldon Springs (0713)
149. Moraine View (0713)
150. Lincoln Trail Homestead (0713)
151. Spitler Woods (0713)
152. Eagle Creek (0714)
153. Wolf Creek (0714)
154. Sangchris Lake (0713)
155. Beaver Dam (0713)
156. Pere Marquette (0713)
157. Ramsey Lake (0714)
158. Frank Holten (0714)
159. Eldon Hazlet (0714)
160. South Shore (0714)
161. Wayne Fitzgerrell (0714)
162. Pyramid (0714)
163. Lake Murphysboro (0714)
164. Giant City (0714)

MISSOURI

165. Battle of Athens (0710)
166. Wyaconda (0711)
167. Mark Twain (0711)
168. Cuivre River (0711)
169. Castlewood (0714)
170. Mastadon (0714)
171. Meramec (0714)
172. Washington (0714)
173. St. Francois (0714)
174. St. Joe (0714)
175. Hawn (0714)
176. Trail of Tears (0714)

STATE FORESTS

MINNESOTA

1. Mississippi Headwaters (0701)
2. Buena Vista (0701)
3. Blackduck (0701)
4. Bowstring (0701)
5. George Washington (0701)
6. Golden Anniversary (0701)
7. Remer (0701)
8. Battleground (0701)
9. Welsh Lake (0701)
10. Paul Bunyan (0701)
11. White Earth (0701)
12. Two Inlets (0701)
13. Smokey Hills (0701)
14. Huntersville (0701)
15. Lyons (0701)
16. Foothills (0701)
17. Badoura (0701)
18. Land O'Lakes (0701)
19. Hill River (0701)
20. Savanna (0701)
21. Fond du Lac (0703)
22. Solana (0703)
23. Wealthwood (0701)
24. Emily (0701)
25. Crow Wing (0701)
26. Pillsbury (0701)
27. Birch Lake (0701)
28. Rum River (0703)
29. Snake River (0703)
30. General Andrews (0703)
31. O.A.R. (0703)
32. Nemadji (0703)
33. St. Croix (0703)
34. Chengwatana (0703)
35. Sand Dunes (0701)
36. Richard J. Dorer Memorial Hardwood (0704, 0706)

WISCONSIN

37. St. Croix River (0703)
38. Brule River (0703)
39. Northern Highland (0705, 0707)
40. American Legion (0707)
41. Flambeau River (0705)
42. Black River (0704)
43. Kettle Moraine (0709)

IOWA

44. Yellow River (0706)
45. Holst (0710)
46. Stephens (0710)
47. Shimek (0710)

ILLINOIS

48. Big River (0708)
49. Sand Ridge (0713)
50. Hidden Springs (0714)
51. Trail of Tears (0714)

MISSOURI

52. Charles Heath (0711)
53. Clark (0711)
54. Wyaconda Crossing (0711)
55. Elmsie Memorial (0711)
56. Little Indian Creek (0714)
57. Pea Ridge (0714)
58. Huzzah (0714)
59. Indian Trail (0714)
60. Buford Mountain (0714)
61. Little Whitewater (0714)
62. Coldwater (0714)
63. Castor River (0714)
64. Clubb Creek (0714)

FIGURE I-6. STATE AND NATIONAL FORESTS AND PARKS, UPPER MISSISSIPPI REGION

Source: State highway maps for Illinois, Indiana, Iowa, Minnesota, Missouri, South Dakota, Wisconsin, 1981.

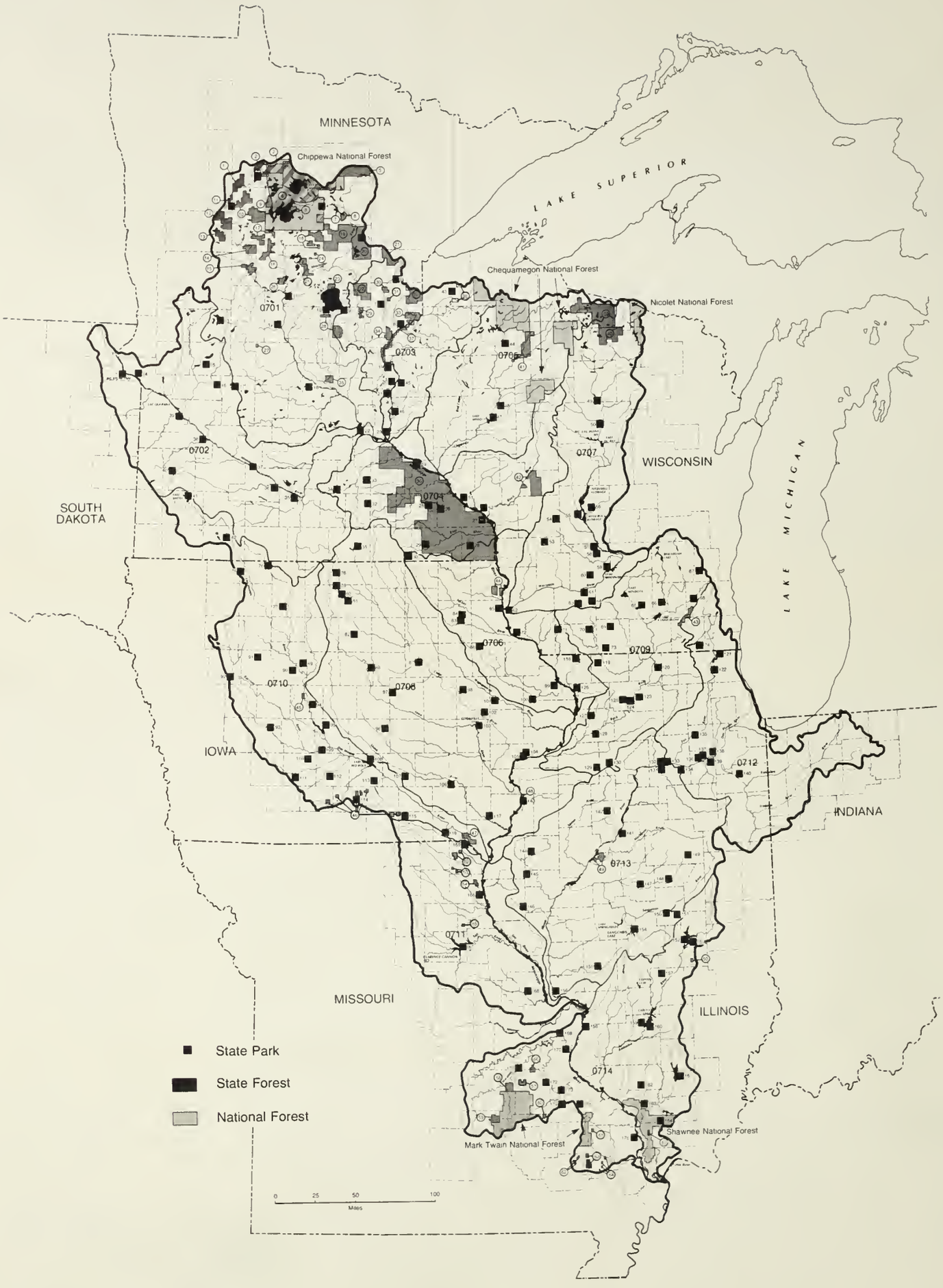

FIGURE I-6. STATE AND NATIONAL FORESTS AND PARKS, UPPER MISSISSIPPI REGION

Source: State highway maps for Illinois, Indiana, Iowa, Minnesota, Missouri, South Dakota, Wisconsin, 1981.

DESIGNATED RECREATION SITES (Numbers correspond to FIGURE I-7)

NATIONAL WILD AND SCENIC RIVER

St. Croix River (MN, WI, 0703)

STATE WILD AND SCENIC RIVERS

1. Kettle River (MN, 0703)
2. Rum River (MN, 0701)
3. Mississippi River (MN, 0701)
4. Crow River (MN, 0701)
5. Minnesota River (MN, 0702)
6. Cannon River (MN, 0704)

NATIONAL TRAILS SYSTEM

1. Cut Foot-Sioux (MN, 0701)
2. Bearskin (WI, 0707)
3. Wisconsin Ice Age (WI, 0703, 0705, 0707, 0709)
4. Elroy-Sparta (WI, 0704, 0707)
5. Sac and Fox (IA, 0708)
6. Illinois Prairie Path (IL, 0712)
7. Elephant Rocks Braille (MO, 0714)

STATE TRAILS

1. Taconite (MN, 0701)
2. Heartland (MN, 0701)
3. Minnesota/Wisconsin Boundary (MN, 0703)
4. Luce Line (MN, 0701)
5. Sakatah Singing Hills (MN, 0702, 0704)
6. Douglas (MN, 0704)
7. Tuscobia (WI, 0705)
8. Bearskin (WI, 0707)
9. Elroy-Sparta (WI, 0704, 0707)
10. Sugar River (WI, 0709)
11. Scotch Grove (IA, 0706)
12. Military Road (IA, 0706, 0709, 0711)
13. Oskaloosa Road (IA, 0708)
14. Burlington Plank (IA, 0708)
15. Morman (IA, 0708, 0710, 0711)
16. Pecatonica Prairie Path (IL, 0709)
17. Grat Western Nature (IL, 0709, 0712)
18. Hennepin Canal Parkway (IL, 0709)
19. Illinois-Michigan Canal Parkway (IL, 0712, 0713)
20. Rock Island (IL, 0713)
21. Great River Road Bikeway (IL, 0711)
22. River to River (IL, 0714)

NATIONAL NATURAL LANDMARKS

NL 1. Itasca Natural Area (MN, 0701)
NL 2. Pine Point Research Natural Area (MN, 0701)
NL 3. Sica Hollow (SD, 0702)
NL 4. Ancient River Warren Channel (MN, SD, 0702)
NL 5. Cedar Creek Natural History Area - Allison Sayanna (MN, 0701)
NL 6. Flambeau River Hemlock - Hardwood Forest (WI, 0705)
NL 7. Finnerud Forest Scientific Area (WI, 0707)
NL 8. Chippewa River Bottoms (WI, 0705)
NL 9. Hayden Prairie (IA, 0706)
NL10. Kickapoo River Natural Area (WI, 0707)
NL11. Baraboo Range (WI, 0707)
NL12. Avoca River - Bottom Prairie (WI, 0707)
NL13. Wyalusing Hardwood Forest (WI, 0707)
NL14. Abraham's Woods (WI, 0709)
NL15. White Pine Hollow Preserve (IA, 0706)
NL16. Anderson Goose Lake (IA, 0708)
NL17. Mississippi Palisades (IL, 0706)
NL18. Volo Bog Nature Preserve (IL, 0712)
NL19. Wauconda Bog Nature Preserve (IL, 0712)
NL20. Busse Forest Nature Preserve (IL, 0712)
NL21. Hoosier Prairie (IN, 0712)
NL22. Pinhook Bog (IN, 0712)
NL23. Funks Grove (IL, 0713)
NL24. Allerton Natural Area (IL, 0713)
NL25. Mark Twain and Cameron Caves (MO, 0711)
NL26. Meramec Spring (MO, 0714)
NL27. Onondaga Cave (MO, 0714)
NL28. Pickle Springs (MO, 0714)
NL29. Little Grand Canyon Area (IL, 0714)
NL30. Giant City (IL, 0714)
NL31. LaRue-Pine Hills Ecological Area (IL, MO, 714)
NL32. Buttonland Swamp (IL, 0714)
NL33. Horseshoe Lake Nature Preserve (IL, 0714)

ICE AGE NATIONAL SCIENTIFIC RESERVES

IA 1. Interstate Park (WI, 0703)
IA 2. Chippewa Moraine (WI, 0705)
IA 3. Mill Bluff State Park (WI, 0707)
IA 4. Devil's Lake State Park (WI, 0707)
IA 5. Cross Plains (WI, 0709)

GREAT RIVER ROAD (not shown)

Roadway along the Mississippi River from its headwaters in Lake Itasca to the Gulf of Mexico (0701, 0704, 0706, 0708, 0711, 0714)

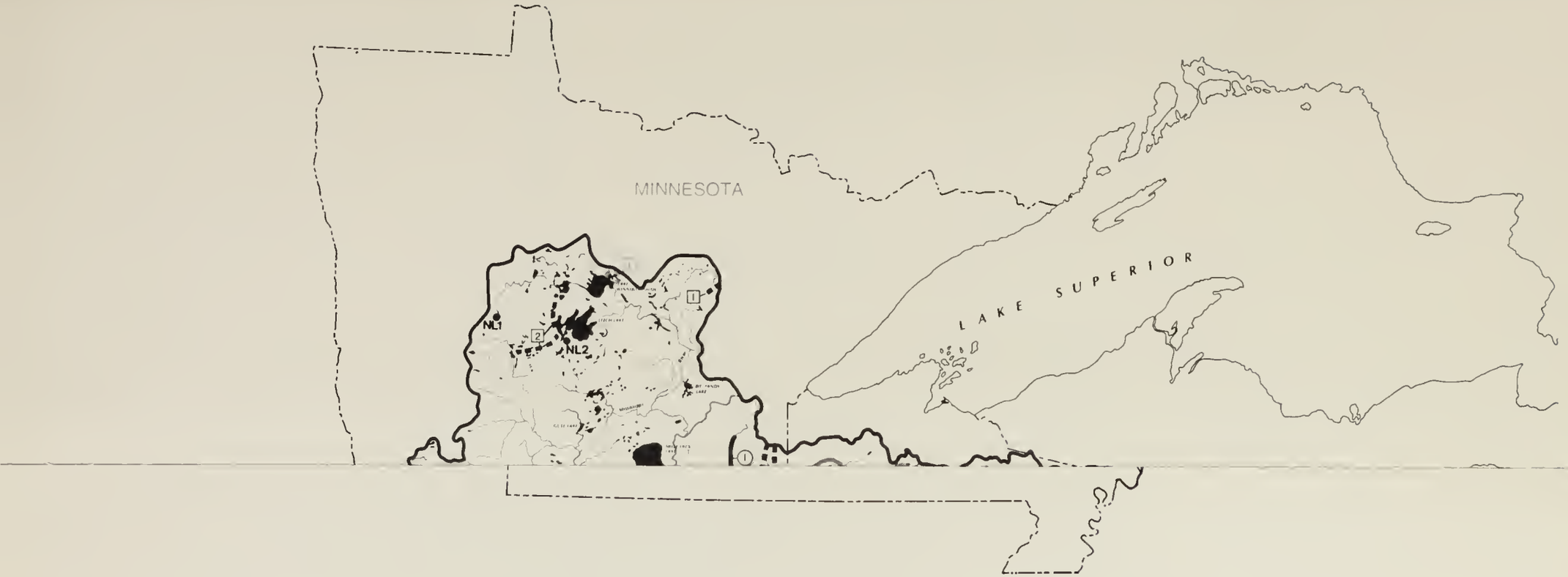

FIGURE I-7. DESIGNATED RECREATION SITES, UPPER MISSISSIPPI REGION

Sources: Iowa Conservation Commission, *1978 SCORP,* 1979.
Minnesota Department of Natural Resources, Office of Planning *Minnesota State Comprehensive Outdoor Recreation Plan*, 1980.
Minnesota Department of Natural Resources, *Recreational Land Trails,* June 1981. (map)
Missouri Department of Conservation, *State and Federal Lands in Missouri,* June 1979. (map)
Staudacher, James J., "Ice Age Summer: the 1,000 Mile Trek" *Wisconsin Natural Resources,* July-August 1980. (map)
U.S. Department of the Interior, Heritage Conservation and Recreation Service, *National Wild and Scenic Rivers System: As Authorized by P.L. 90-542 as Amended,* January 1979. (map)
U.S. Department of the Interior, Heritage Conservation and Recreation Service *National Recreation Trails,* January 1979.
U.S. Department of the Interior, Heritage Conservation and Recreation Service, "National Registry of Natural Landmarks", *Federal Register,* Vol. 45, No. 232, (December 1, 1980), pp. 79698-79723.
Wisconsin Department of Administration, State Planning Office and Wisconsin Department of Natural Resources, *Lands of Special Public Policy Designation, Land Resources Analysis Program,* 1974. (map)
Personal communication with Illinois Department of Conservation, Indiana Department of Natural Resources, Iowa Conservation Commission, Missouri Department of Natural Resources, Wisconsin Department of Natural Resources 1980 and 1981.

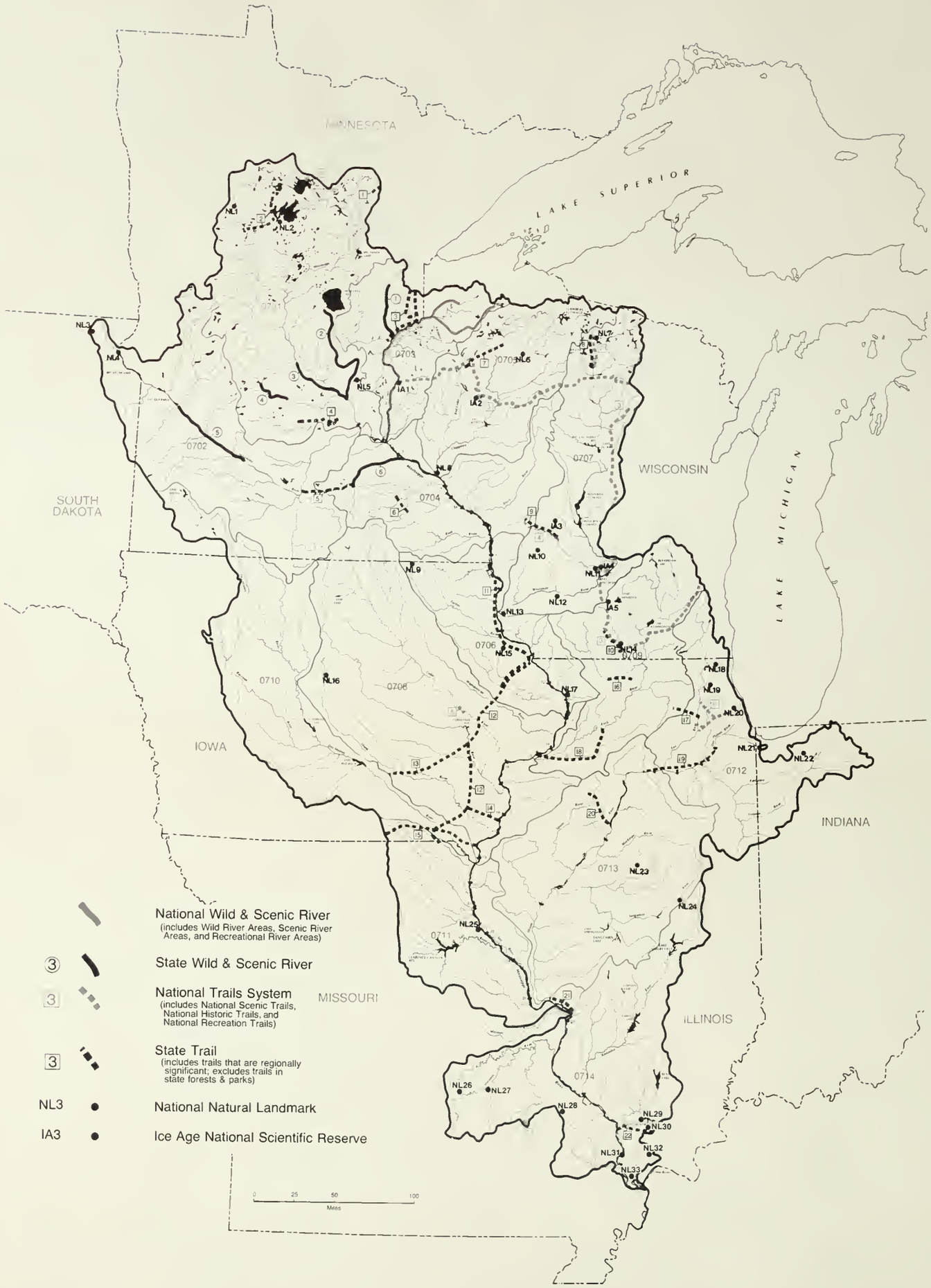

FIGURE I-7. DESIGNATED RECREATION SITES, UPPER MISSISSIPPI REGION

Sources: Iowa Conservation Commission, *1978 SCORP*, 1979.
Minnesota Department of Natural Resources, Office of Planning *Minnesota State Comprehensive Outdoor Recreation Plan*, 1980.
Minnesota Department of Natural Resources. *Recreational Land Trails*, June 1981. (map)
Missouri Department of Conservation, *State and Federal Lands in Missouri*, June 1979. (map)
Staudacher, James J., "Ice Age Summer: the 1,000 Mile Trek" *Wisconsin Natural Resources*, July-August 1980. (map)
U.S. Department of the Interior, Heritage Conservation and Recreation Service, *National Wild and Scenic Rivers System: As Authorized by P.L. 90-542 as Amended*, January 1979. (map)
U.S. Department of the Interior, Heritage Conservation and Recreation Service *National Recreation Trails*, January 1979.
U.S. Department of the Interior, Heritage Conservation and Recreation Service, "National Registry of Natural Landmarks", *Federal Register*, Vol. 45, No. 232, (December 1, 1980), pp. 79698-79723.
Wisconsin Department of Administration, State Planning Office and Wisconsin Department of Natural Resources, *Lands of Special Public Policy Designation, Land Resources Analysis Program*, 1974. (map)
Personal communication with Illinois Department of Conservation, Indiana Department of Natural Resources, Iowa Conservation Commission, Missouri Department of Natural Resources, Wisconsin Department of Natural Resources 1980 and 1981.

MAJOR DAMS AND RESERVOIRS (Numbers correspond to FIGURE I-8)

	RESERVOIR	IMPOUNDMENT CAPACITY (acre-feet)	PURPOSE (in order of importance)
1.	Leech Lake (MN, 0701)	1,000,000	Flood Control, Recreation
2.	Lake Winnibigoshish (MN, 0701)	1,072,000	Flood Control, Recreation
3.	Mud and Goose Lake (MN, 0701)	44,870	Wildlife
4.	Pokegama (MN, 0701)	129,600	Flood Control, Recreation
5.	Prairie Lake (MN, 0701)	15,840	Hydroelectric
6.	Big Rice Lake (MN, 0701)	13,465	Lake control, Irrigation
7.	Pine River Reservoir (MN, 0701)	193,500	Flood Control, Recreation
8.	Gull Lake Reservoir (MN, 0701)	111,000	Flood Control, Recreation
9.	Sylvan Lake (MN, 0701)	10,430	Hydroelectric
10.	Rice Lake (MN, 0701)	16,300	Hydroelectric
11.	Sandy Lake (MN, 0701)	109,200	Flood Control, Recreation
12.	Rice River Pool (MN, 0701)	38,000	Waterfowl
13.	Rice Lake Pool (MN, 0701)	13,820	Waterfowl
14.	Minong Flowage (WI, 0703)	22,000	Recreation, Hydroelectric
15.	Nelson Lake (Totagatic Flowage) (WI, 0703)	44,000	Recreation
16.	Lake Namekagon (WI, 0703)	52,032	Recreation
17.	Lake Chippewa (WI, 0705)	332,100	Storage, Recreation
18.	Moose Lake (WI, 0705)	18,120	Recreation
19.	Price Flowage (WI, 0705)	10,490	Recreation
20.	Flambeau Flowage (WI, 0705)	370,000	Watersupply, Recreation
21.	Rest Lake (WI, 0705)	17,500	Recreation
22.	Plum Lake (WI, 0707)	18,760	Recreation
23.	South and North Twin Lakes (WI, 0707)	81,640	Storage, Recreation
24.	Seven Mile Lake (WI, 0707)	11,460	Storage, Recreation
25.	Sand, Echo, & Chain Lakes (WI, 0707)	17,440	Storage, Recreation
26.	Rainbow Flowage (WI, 0707)	86,040	Storage, Recreation
27.	Minocqua Reservoir (WI, 0707)	32,710	Storage, Recreation
28.	Flambeau (WI, 0705)	42,290	Recreation
29.	Willow Reservoir (WI, 0707)	73,590	Storage, Flood Control
30.	Solborg Lake (WI, 0705)	10,470	Recreation
31.	Dairyland Reservoir (WI, 0705)	57,810	Hydroelectric, Recreation
32.	Red Cedar and Hemlock Lakes (WI, 0705)	68,630	Recreation
33.	Rice Lake (WI, 0705)	10,770	Hydroelectric, Recreation
34.	Birch Lake (WI, 0705)	10,500	Recreation
41.	Indian Head Flowage (WI, 0703)	12,750	Hydroelectric, Recreation
42.	Blanchard Dam (MN, 0701)	15,500	Hydroelectric
43.	Sauk River (MN, 0701) (affects a series of lakes and Cedar Island Lake)	10,000	Hydroelectric
44.	Sauk Lake (MN, 0701)	19,600	Recreation
45.	Lake Florida Slough (MN, 0702)	14,500	Fish and Wildlife Protection
46.	Lac Qui Parle Reservoir (MN, 0702)	122,800	Flood Control, Recreation
47.	Marsh Lake (MN, 0702)	121,300	Flood Control
48.	Big Stone Lake/Whetstone River (MN, 0702)	122,500	Flood Control, Recreation
49.	Pool #2 (MN, 0701)	240,000	Navigation
50.	Byllesby Reservoir (MN, 0704)	25,000	Recreation
51.	Pool #3 (MN, WI, 0704)	350,000	Navigation
52.	Eau Galle Reservoir (WI, 0705)	56,900	Flood Control, Recreation
53.	Lake Menominee (WI, 0705)	20,500	Hydroelectric, Recreation
54.	Tainter Lake (WI, 0705)	36,500	Hydroelectric, Recreation
55.	Altoona Lake (WI, 0705)	11,000	Recreation
56.	Lake Eau Claire (WI, 0705)	15,100	Recreation
57.	Lake Wissota (WI, 0705)	226,340	Hydroelectric
58.	Old Abe Lake (WI, 0705)	21,450	Hydroelectric, Recreation
59.	Otter Lake (WI, 0705)	15,000	Recreation
60.	Cornell Flowage (WI, 0705)	22,280	Hydroelectric, Recreation
61.	Chetek Flowage (WI, 0705)	41,700	Hydroelectric, Recreation
62.	Chain of Lakes (WI, 0705)	28,170	Recreation
63.	Holcombe Flowage (WI, 0705)	72,000	Hydroelectric, Recreation
64.	Chequamegon Waters (WI, 0705)	30,320	Recreation
65.	Spirit River Flowage (WI, 0707)	26,550	Storage, Recreation
66.	Lake Mohawksin (WI, 0707)	15,180	Hydroelectric, Recreation
67.	Lake Nakomis (WI, 0707)	25,940	Storage, Recreation
68.	Lake Alice (WI, 0707)	14,400	Hydroelectric, Recreation
69.	Merrill (WI, 0707)	11,700	Hydroelectric, Recreation
70.	Lake Wausau (WI, 0707)	20,170	Hydroelectric, Recreation
71.	Big Eau Pleine Reservoir (WI, 0707)	161,240	Storage, Flood Control, Recreation
72.	Lake Ou Bay (WI, 0707)	102,730	Hydroelectric, Recreation
73.	Wisconsin River Flowage (WI, 0707)	12,000	Hydroelectric, Recreation
74.	Biron Flowage (WI, 0707)	22,680	Hydroelectric Flood Control, Recreation
75.	Lake Arbutus (WI, 0704)	23,400	Hydroelectric, Recreation
76.	Pool #4 (MN, WI, 0704)	878,000	Navigation
77.	Zumbro Lake (MN, 0704)	35,000	Hydroelectric
78.	Pool #5 (MN, WI, 0704)	106,600	Navigation
79.	Pool #5A (MN, WI, 0704)	39,600	Navigation
80.	Pool #6 (MN, WI, 0704)	566,000	Navigation
81.	Pool #7 (MN, WI, 0704)	105,000	Navigation
82.	Pool #8 (MN, WI, 0706)	197,400	Navigation
83.	Pool #9 (IA, WI, 0706)	270,000	Navigation
84.	Petenwell Flowage (WI, 0707)	547,100	Hydroelectric, Flood Control
85.	Castle Rock Flowage (WI, 0707)	240,960	Hydroelectric, Flood Control, Recreation
86.	Lake Redstone (WI, 0707)	16,670	Recreation
87.	Lake Wisconsin (WI, 0707)	80,000	Hydroelectric, Recreation
88.	Lake Mendota (WI, 0709)	295,200	Recreation
89.	Beverdam Lake (WI, 0709)	56,850	Recreation
90.	Fox Lake (WI, 0709)	27,500	Recreation
91.	Theresa Marsh (WI, 0709)	20,700	Recreation
92.	Sinissippi Lake (WI, 0709)	18,715	Recreation
93.	Lake Koshkonong (WI, 0709)	185,600	Recreation
94.	Pool #10 (IA, WI, 0706)	212,000	Navigation
95.	Pool #11 (IA, WI, 0706)	244,300	Navigation
96.	Pool #12 (IA, IL, 0706)	92,000	Navigation
97.	Carroll Lake (IL, 0706)	21,630	Recreation
98.	Pool #13 (IA, IL, 0708)	192,000	Navigation
99.	Lake Geneva (WI, 0712)	500,000	Recreation
100.	McHenry Lock and Dam (IL, 0712)	42,000	Recreation
101.	Thomas J. O'Brien Controlling Works (IL, 0712)	10,700	Navigation
102.	Lockport Pool (IL, 0712)	18,000	Navigation
103.	Oresden Island Pool (IL, 0712)	12,000	Navigation
104.	Oresden Cooling Lake (IL, 0712)	20,083	Cooling Water
105.	Marseilles Pool (IL, 0712)	14,000	Navigation
106.	Starved Rock Pool (IL, 0713)	16,000	Navigation
107.	Pool #14 (IA, IL, 0708)	82,000	Navigation
108.	Pool #15 (IA, IL, 0708)	30,000	Navigation
109.	Pool #16 (IA, IL, 0708)	88,000	Navigation
110.	Pool #17 (IA, IL, 0708)	50,000	Navigation
111.	Lake Macbride (IA, 0708)	13,000	Recreation
112.	Coralville Reservoir (IA, 0708)	585,000	Flood Control, Recreation
113.	Lake Ponderosa (IA, 0708)	36,000	Recreation
114.	Rock Creek Lake (IA, 0708)	13,000	Recreation
115.	Big Creek Lake (IA, 0710)	35,500	Flood Control
116.	Big Creek Lake (IA, 0710)	27,500	Flood Control
117.	Saylorville Lake (IA, 0710)	670,000	Flood Control
118.	Lake Panorama (IA, 0710)	23,700	Recreation
119.	Roberts Creek Lake (IA, 0710)	21,863	Recreation
120.	Lake Red Rock (IA, 0710)	1,830,000	Flood Control, Recreation
121.	Pool #18 (IA, IL, 0708)	90,000	Navigation
122.	Spoon Lake (IL, 0713)	15,000	Recreation
123.	Powerton Cooling Lake (IL, 0713)	15,600	Cooling Water
124.	Peoria Pool (IL, 0713)	225,000	Navigation
125.	Farmdale Reservoir (IL, 0713)	15,500	Flood Control
126.	Evergreen Lake (IL, 0713)	13,500	Water Supply
127.	LaGrange Pool (IL, 0713)	55,000	Navigation
128.	Lake Keokuk (Pool #19) (IA,IL,0708)	292,000	Hydroelectric, Navigation
129.	Pool #20 (IL, MO, 0711)	58,000	Navigation
130.	Pool #21 (IL, MO, 0711)	62,000	Navigation
131.	Pool #22 (IL, MO, 0711)	80,000	Navigation
132.	Pool #24 (IL, MO, 0711)	125,363	Navigation, Recreation
133.	Otter Lake (IL, 0713)	15,450	Water Supply
134.	Lake Springfield (IL, 0713)	62,614	Water Supply, Recreation, Cooling Water
135.	Sangchris Lake (IL, 0713)	35,141	Cooling Water
136.	Lake Taylorville (IL, 0713)	10,394	Recreation
137.	Lake Decatur (IL, 0713)	22,340	Water Supply, Recreation
138.	Lake Shelbyville (IL, 0714)	1,035,900	Flood Control, Navigation, Recreation, Water Supply
139.	Lake Lou Yaeger (IL, 0714)	20,500	Water Supply, Recreation, Flood Control
140.	Pool #25 (IL, MO, 0711)	176,000	Navigation, Recreation
141.	Alton Lake (Pool #26) (IL, MO, 0711)	169,443	Navigation, Recreation
142.	Coffeen Lake (IL, 0714)	28,400	Cooling Water
143.	Greenville New City Lake (IL, 0714)	12,400	Water Supply
144.	Carlyle Lake (IL, 0714)	1,287,000	Flood Control, Water Supply, Navigation, Recreation
145.	Rend Lake (IL, 0714)	608,000	Flood Control, Recreation, Water Supply, Other
146.	Baldwin Reservoir (IL, 0714)	26,000	Water Supply for Power Plant
147.	Kaskaskia River Navigation Pool (IL, 0714)	25,246	Navigation
148.	Slime Pond (MO, 0714)	22,608	Tailings Pond
149.	Mo-no name #122 (MO, 0714)	12,720	Tailings Pond
150.	Kinkaid Lake (IL, 0714)	79,000	Water Supply, Recreation
151.	Cedar Lake (IL, 0714)	41,500	Water Supply
152.	IL-no name #78 (IL, 0714)	80,000	Flood Control
153.	Crab Orchard Lake (IL, 0714)	166,000	Recreation, Water Supply, Migratory Wildfowl Refuge
154.	Devil's Kitchen Lake (IL, 0714)	106,351	Recreation, Water Supply
155.	Little Grassy Lake (IL, 0714)	34,320	Recreation, Migratory Wildfowl Refuge

FIGURE I-8. MAJOR DAMS AND RESERVOIRS*, UPPER MISSISSIPPI REGION

*Maximum impoundment capacity > 10,000 acre-feet

Sources: U.S. Army Corps of Engineers, *Inventory of Federal and Non-Federal Dams,* Illinois, 1976; *Inventory of Federal and Non-Federal Dams*, Iowa, 1976; *Inventory of Federal and Non-Federal Dams,* Minnesota, 1975; *Inventory of Federal and Non-Federal Dams,* Missouri, 1976; *Inventory of Federal and Non-Federal Dams,* Wisconsin, 1975.

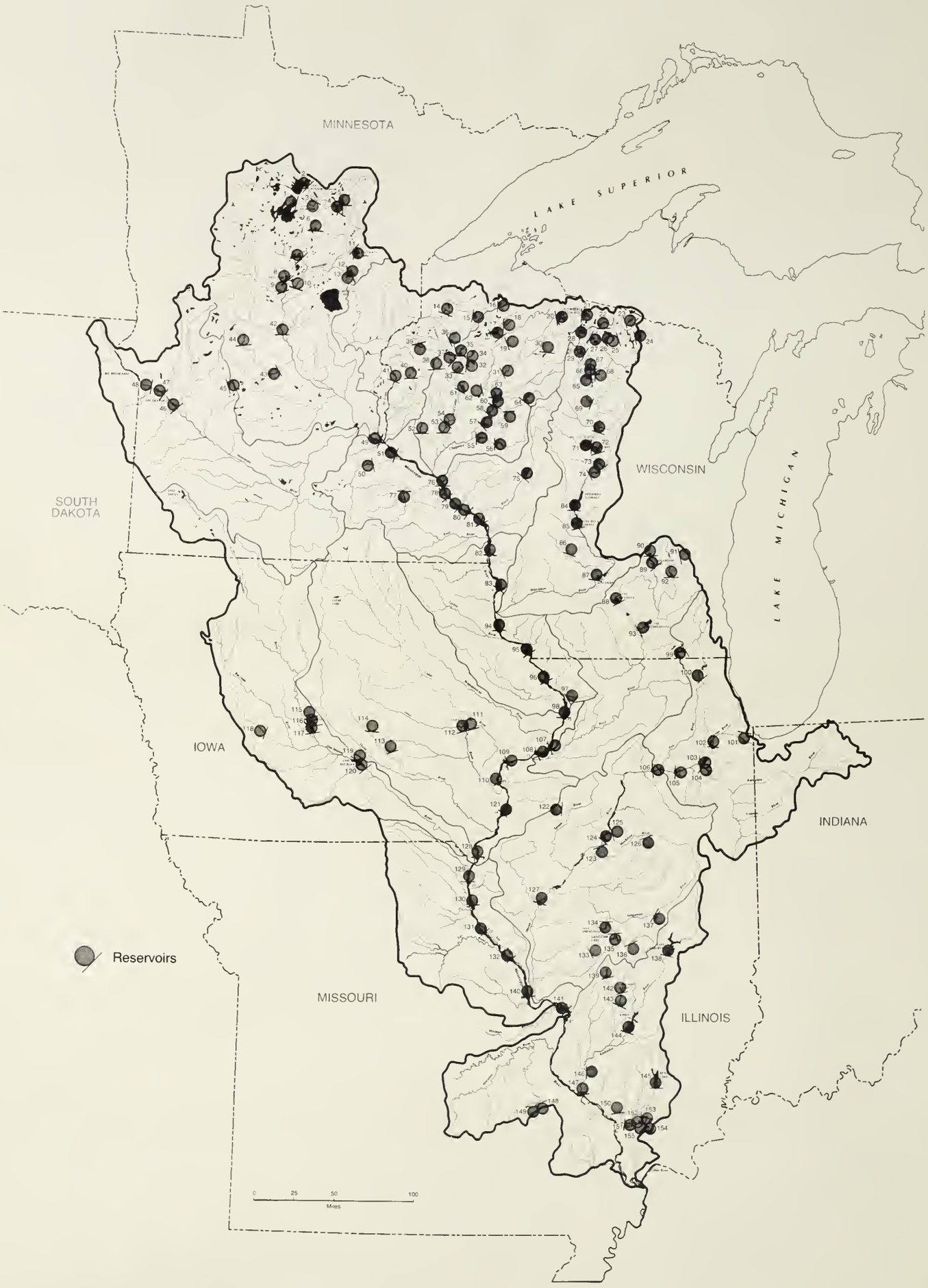

FIGURE I-8. MAJOR DAMS AND RESERVOIRS*, UPPER MISSISSIPPI REGION

*Maximum impoundment capacity > 10,000 acre-feet

Sources: U.S. Army Corps of Engineers, *Inventory of Federal and Non-Federal Dams,* Illinois, 1976; *Inventory of Federal and Non-Federal Dams,* Iowa, 1976; *Inventory of Federal and Non-Federal Dams,* Minnesota, 1975; *Inventory of Federal and Non-Federal Dams,* Missouri, 1976; *Inventory of Federal and Non-Federal Dams,* Wisconsin, 1975.

River, from its source in north-central Minnesota to its confluence with the Ohio River at the southern border of Illinois, is the dominant surface water feature. Along this stretch, the Mississippi changes from a swift, relatively shallow stream to a large, slow-moving, and turbid river. The velocity of the river below central Minnesota has been further slowed by the construction of the lock and dam system and upstream impoundments (Figure I-8). Besides dams, climate and runoff characteristics influence flow patterns of all streams. Rivers with the highest average flows include the Mississippi, Illinois, Wisconsin, Chippewa, Des Moines, and Cedar rivers (Figure I-9). Seasonal flow variations are most extreme in the west and south where many small streams are completely

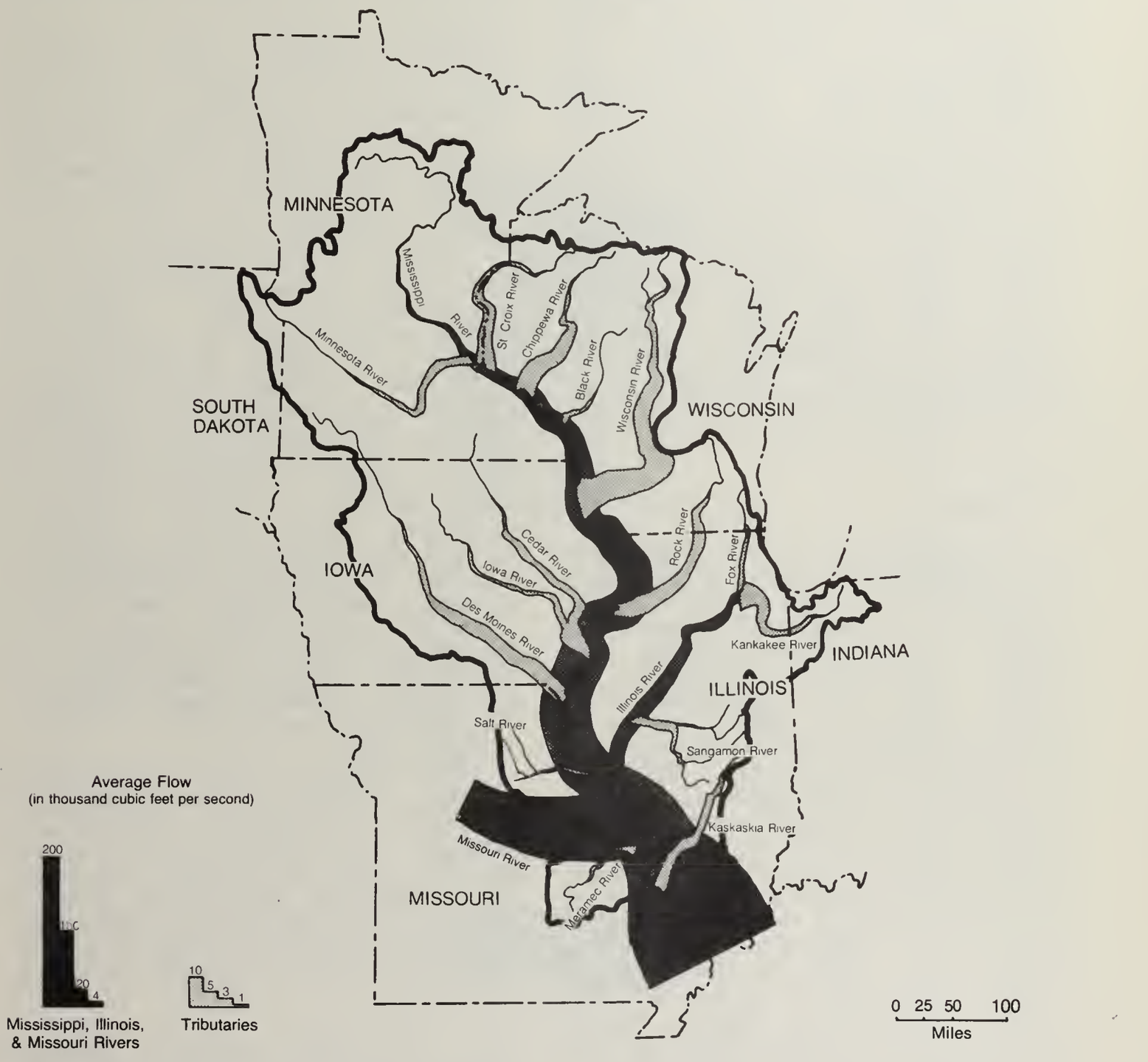

FIGURE I-9. AVERAGE FLOW OF SELECTED STREAMS, UPPER MISSISSIPPI REGION

Source: U.S. Geological Survey, Unpublished instream flow data through 1976.

dewatered during the dry season. Groundwater in these areas cannot maintain adequate baseflows, and flows are sometimes further reduced by excessive surface water withdrawals and pumpage from shallow sand and gravel aquifers. Numerous surface water impoundments in the south regulate flows.

The inequitable distribution of surface water both in quantity and quality can lead to resource problems that limit use for supply, recreation, and fishery production. The largest amount of surface water is in the north and in the counties contiguous to the Mississippi River (Figure I-10). Numerous small and medium-sized lakes and large reservoirs in northern and central Minnesota constitute the greatest water concentration. Northern Wisconsin also has many lakes and reservoirs. In the southern and western parts of the region, natural lakes are sparse and reservoirs are the major surface water feature. Unfortunately, surface water needs in the south and west are large because of unreliable groundwater supplies. Competition for available water resources will increase conflicts during droughts.

Groundwater

Large supplies of fresh groundwater are available for much of the Upper Mississippi Region even as use is rapidly increasing. Groundwater occurs in several different water-yielding formations or aquifers. Aquifers are divided into the unconsolidated and bedrock categories. Unconsolidated or surficial aquifers consist mainly of glacial deposits and alluvium. The principal water-yielding surficial aquifers are the sands and gravels associated with major streams (alluvial aquifers) and the outwash deposited by melt-water streams. The alluvium and outwash deposits are the most productive part of the groundwater system in the Upper Mississippi Region (Figure I-11). Sands and gravels buried in pre-glacial bedrock valleys are also highly productive. Buried channel aquifers are in various parts of the region, but the most extensive system is in the Mahomet bedrock valley of east-central Illinois.[3]

Sands and gravels within glacial drift provide an important local source of water supply, but the physical composition of these deposits vary locally. Therefore, the groundwater potential is difficult to assess locally or regionally.

The Upper Mississippi Region is underlain by layers of dolomites, limestones, shales, and sandstones that vary in thickness and hydrologic characteristics. Groundwater is in the intergranular spaces of these rocks which overlie a basement complex of rocks. These granitic rocks are at or near the land surface in the northern part of the region and in the Ozark Dome just south of the region. Rocks of younger age and different water-yielding characteristics outcrop in successive belts around these centers of uplift (Figure I-12).

The most productive bedrock aquifers are of the Cambrian-Ordovician and Silurian-Devonian ages. Cambrian-Ordovician aquifers that consist of sandstone and dolomite formations are a major water source in southeastern Minnesota, southern Wisconsin, northern Illinois, Iowa, northwestern Indiana, and much of eastern Missouri. Silurian-Devonian aquifers of limestone and dolomite formations supply water to northeastern Iowa, northern Illinois, southeastern Wisconsin, and northwestern Indiana. As these bedrock formations dip to greater depths in central and southern Illinois, southwestern Iowa, and northeastern Missouri, the groundwater is too brackish for use. Pennsylvanian and Mississippian sandstone and limestones can often yield small supplies of water in these areas.

The climate, soil, vegetation, minerals, and water of a region are all necessary for continued livelihood and progress. In the Upper Mississippi Region, these and related resources enable population and economic growth. However, the utilization and management of the physical resources while promoting development remains a regional challenge.

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[3]U.S. Geological Survey, Summary Appraisals of the Nation's Ground-Water Resources--Upper Mississippi Region. Professional Paper 813-B, 1975.

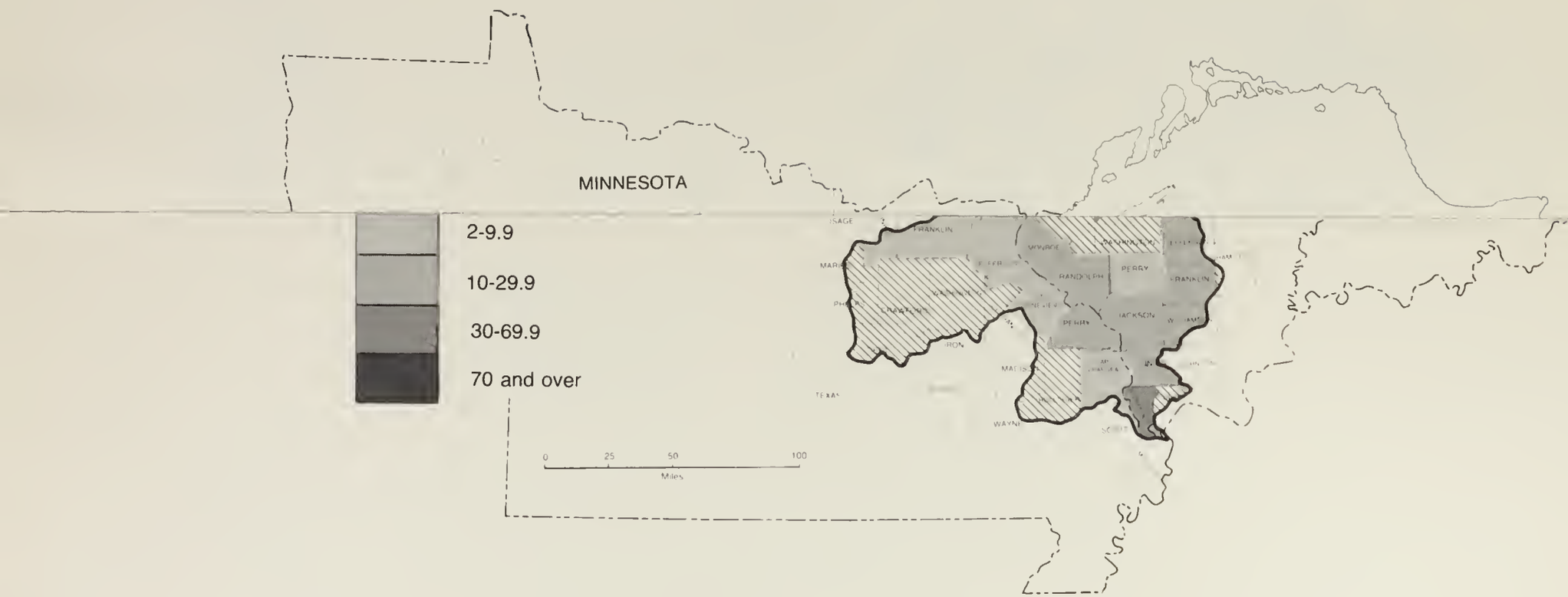

FIGURE I-10. SURFACE WATER RATIO BY COUNTY, UPPER MISSISSIPPI REGION

Source: U.S. Department of Agriculture, Soil Conservation Service, *1979 National Resources Inventory,* 1979. (unpublished data)

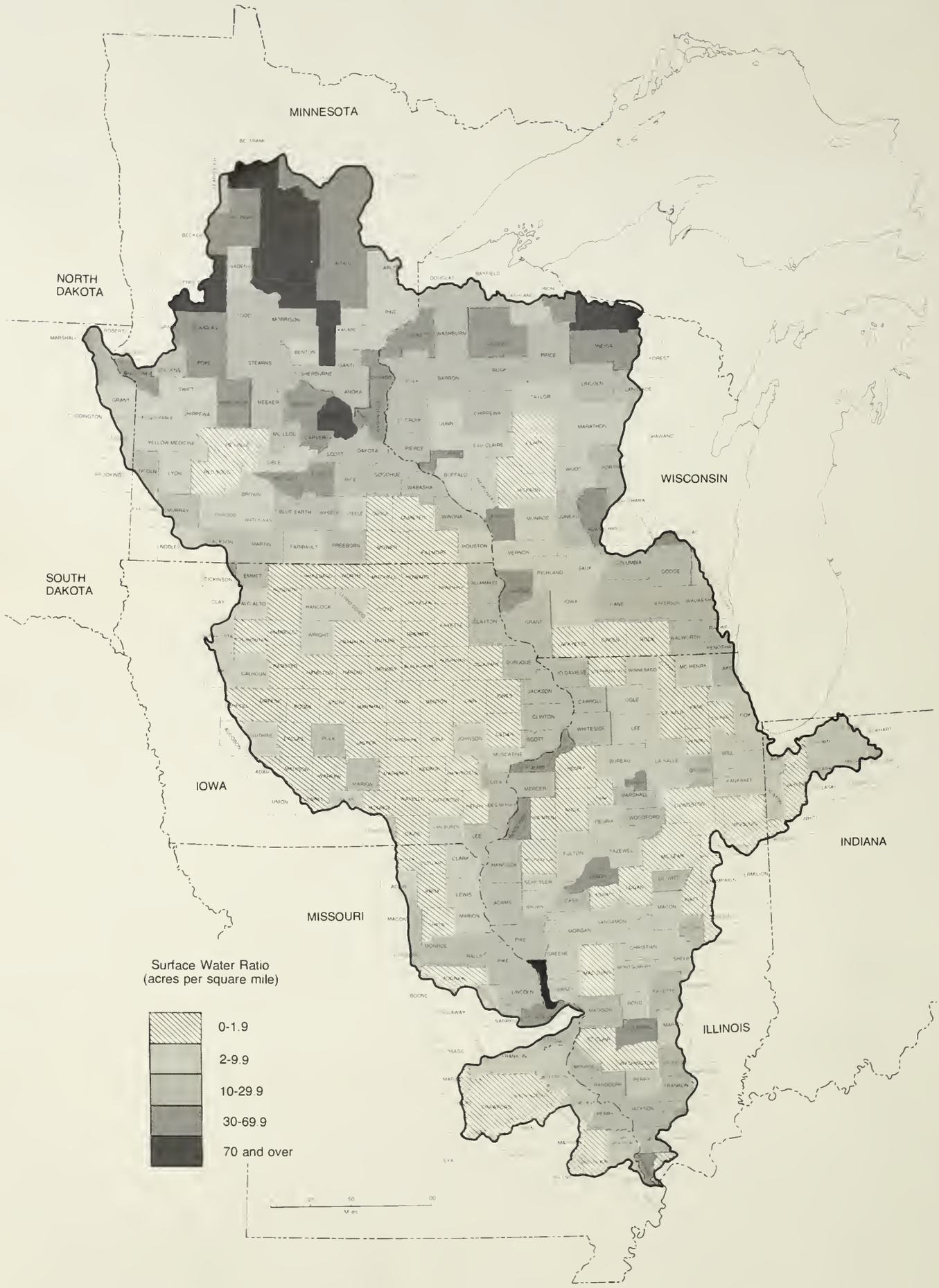

FIGURE I-10. SURFACE WATER RATIO BY COUNTY, UPPER MISSISSIPPI REGION

Source: U.S. Department of Agriculture, Soil Conservation Service, *1979 National Resources Inventory*, 1979. (unpublished data)

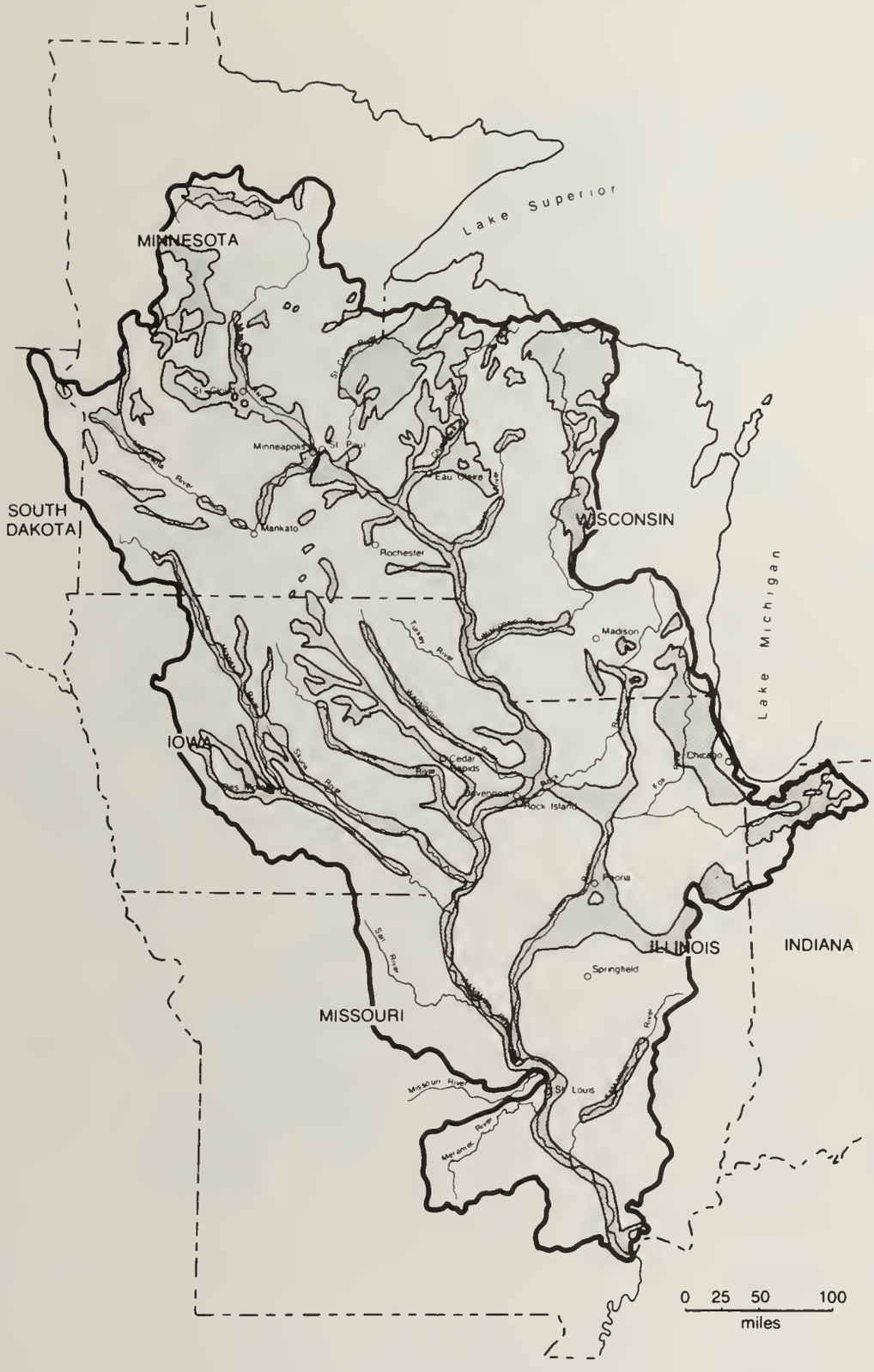

FIGURE I-11. OUTWASH AND ALLUVIAL DEPOSITS, UPPER MISSISSIPPI REGION

Source: U.S. Geological Survey, *Summary Appraisals of the Nation's Ground-Water Resources – Upper Mississippi Region,* Professional Paper 813-B, 1975.

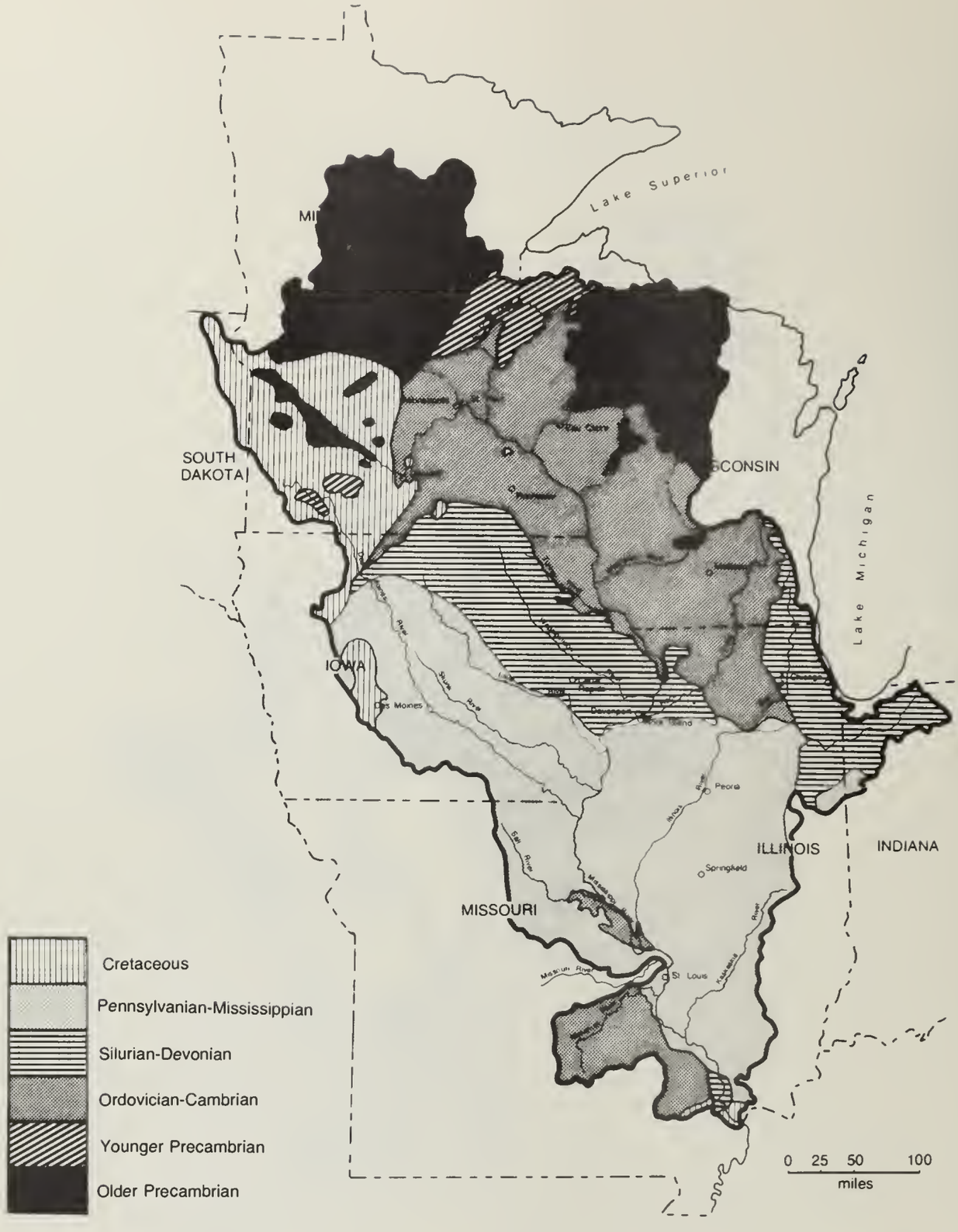

FIGURE I-12. GROUNDWATER GEOLOGY OF UPPER BEDROCK,* UPPER MISSISSIPPI REGION

*Bedrock units are at land surface or are overlain by unconsolidated glacial, river, or windblown deposits of variable thickness. Cretaceous water yields are fair to high from sand and gravel formations. Pennsylvanian-Mississippian water yields are low. Silurian-Devonian (limestone and dolomite) water yields are variable. Ordovician-Cambrian limestone, dolomite, and shale formations have water yields that are generally low. Ordovician-Cambrian sandstone formations have water yields that are generally high. Precambrian formations do not generally yield water.

Source: U.S. Geological Survey, *Summary Appraisals of the Nation's Ground-Water Resources – Upper Mississippi Region,* Professional Paper 813-B, 1975.

The economy of a region depends on the physical resources. In the Upper Mississippi Region, the varied physical resources have enabled the development of a diversified economy. Agriculture, forestry, manufacturing, and mining are integral components of the region's economy and have shaped land use patterns. Population centers develop where resources can be produced or transported economically. The natural transportation network of rivers and lakes was fundamental to the initial settlement and development of the region. The Mississippi River, Illinois River, and Great Lakes remain vital transportation resources for exporting grain and importing coal and petroleum products. This same transportation network, as well as numerous other streams and lakes, and the forests provide recreation opportunities.

Population and Economy

The Upper Mississippi Region comprises the central and western portions of the Middle West. Although the Middle West is an agricultural region,[4] it is not rural because most of the inhabitants live in places with a population over 2500.[5] Current population in the region is approximately 20.5 million, half of which is in Illinois (Table I-4). In all states of the region except Iowa and South Dakota more than 50 percent of the population live in metropolitan areas.[6] Chicago, Minneapolis-St.Paul, and St. Louis are the largest metropolitan areas with a diversified population and

[4]John Fraser Hart discerned that ". . .counties which had at least one real farm per square mile in 1964 were concentrated, to a remarkable degree in the Middle West;. . ." He defined a real farm as having sales of farm products which totalled $10,000 or more in 1964. John F. Hart, The Look of the Land, 1975.

[5]The U.S. Bureau of the Census differentiates urban from rural population when the inhabitants live in places of 2,500 or more.

[6]Population Reference Bureau, Distribution of U.S. Population, 1976. (map)

TABLE I-4. POPULATION CHARACTERISTICS, UPPER MISSISSIPPI REGION

	1970		1975		1980		1990		2000	
	OBERS "E"	States	OBERS "E"	States	OBERS "E"	States	OBERS "E"	States	OBERS "E"	States
POPULATION (millions)										
Upper Mississippi Region	20.0	20.0	20.3	20.2	21.7	20.8	23.5	22.6	25.0	24.5
State Portions										
Illinois	10.44	10.44	10.55	10.52	11.50	10.83	12.48	11.80	13.32	13.20
Indiana	0.16	0.16	0.16	0.16	0.17	0.17	0.19	0.19	0.20	0.20
Iowa	2.27	2.27	2.30	2.32	2.36	2.37	2.45	2.50	2.50	2.60
Minnesota	3.20	3.20	3.31	3.31	3.54	3.46	3.99	3.79	4.35	4.02
Missouri	2.16	2.16	2.15	2.14	2.30	2.13	2.41	2.23	2.49	2.22
South Dakota	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Wisconsin	1.71	1.71	1.79	1.73	1.84	1.83	1.99	2.07	2.11	2.26
Standard Metropolitan Statistical Areas										
Bloomington	0.10	0.10	0.11	0.11	0.12	0.12	0.13	0.13	0.13	0.15
Cedar Rapids	0.16	0.16	0.17	0.17	0.17	0.17	0.17	0.17	0.18	0.18
Chicago	6.99	6.99	6.99	6.99	7.66	7.25	8.35	7.94	8.96	8.88
Davenport-Rock Island-Moline	0.36	0.36	0.37	0.37	0.38	0.38	0.40	0.42	0.40	0.46
Decatur	0.13	0.13	0.13	0.13	0.14	0.12	0.15	0.14	0.16	0.15
Des Moines	0.31	0.31	0.32	0.33	0.32	0.35	0.34	0.39	0.35	0.41
Dubuque	0.09	0.09	0.09	0.09	0.09	0.10	0.09	0.11	0.09	0.12
Eau Claire	0.12	0.12	0.12	0.12	0.11	0.12	0.12	0.14	0.12	0.15
Kankakee	0.10	0.10	0.10	0.10	0.10	0.10	0.12	0.10	0.12	0.11
La Crosse	0.08	0.08	0.08	0.08	0.09	0.09	0.10	0.09	0.10	0.10
Madison	0.29	0.29	0.30	0.30	0.33	0.32	0.36	0.35	0.40	0.37
Minneapolis-St. Paul	1.97	1.97	2.04	2.03	2.21	2.15	2.53	2.38	2.80	2.56
Peoria	0.34	0.34	0.35	0.35	0.38	0.36	0.41	0.39	0.44	0.43
Rochester	0.08	0.08	0.09	0.09	0.10	0.10	0.10	0.11	0.11	0.13
Rockford	0.27	0.27	0.28	0.27	0.31	0.27	0.34	0.31	0.37	0.36
St. Cloud	0.13	0.13	0.14	0.14	0.15	0.16	0.17	0.18	0.19	0.20
St. Louis	1.83	1.83	1.82	1.79	1.96	1.77	2.06	1.80	2.12	1.80
Springfield	0.17	0.17	0.17	0.18	0.19	0.18	0.20	0.20	0.22	0.23
Waterloo-Cedar Rapids	0.13	0.13	0.13	0.14	0.14	0.14	0.14	0.15	0.15	0.15

Source: UMR8C, Socio-Economic Information System (OBERS "E"-1972, OBERS "E"-States), July 1978.

economy that distinguish them from the rest of the region. Other dense population areas include the smaller Standard Metropolitan Statistical Areas (Figure I-14).[7] Counties in the north and west have the lowest population densities.

Population growth is projected to be gradual perhaps reaching 25 million by 2000. Most of this expansion will occur in major cities and their surrounding counties, while many rural counties will have significant out-migration. Proportionally, Minnesota and Wisconsin expect the greatest population increase in the region while Missouri and Iowa the least (Figure I-13). The subregions with the large metropolitan areas--Mississippi Headwaters (Minneapolis-St. Paul), Upper Illinois (Chicago), Kaskaskia-Meramec (St. Louis)--will remain the most populated; and the greatest proportional increases are projected for the Mississippi Headwaters, Rock, Upper Illinois, and Lower Illinois subregions.

Similar economic growth is anticipa-

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[7]A Standard Metropolitan Statistical Area is defined by the Office of Management and Budget as containing at least one city (or twin cities) of 50,000 or more population, the county in which it is located, and any adjacent counties that are both metropolitan in character and socially and economically integrated with the central city.

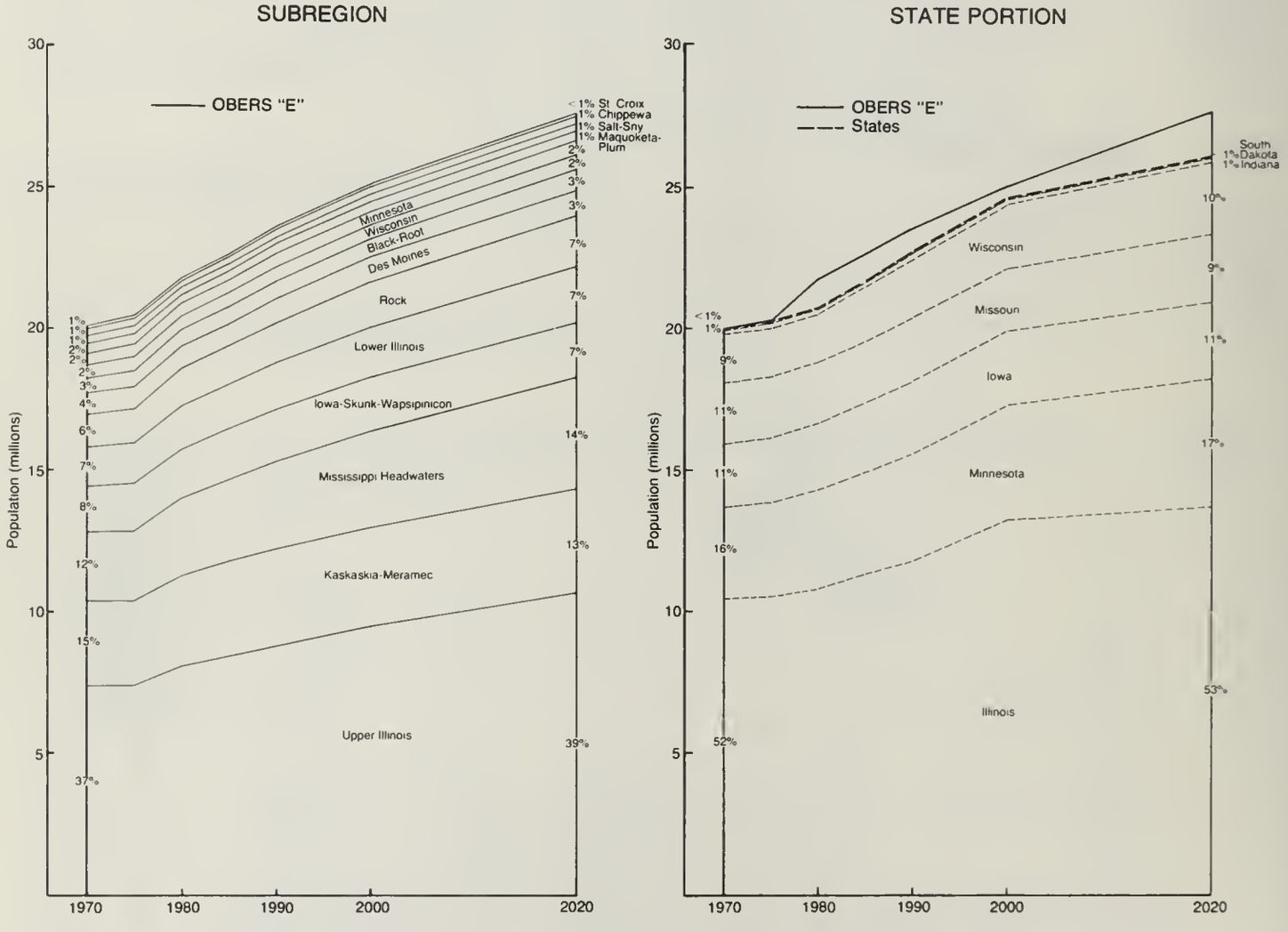

FIGURE I-13. POPULATION PROJECTION TO 2020*, UPPER MISSISSIPPI REGION

*Rounding prevent percentages from totaling always to 100% in figures and tables of this plan.

Source: UMRBC, Socio-Economic Information System (OBERS "E" — 1972, OBERS "E" — States), July 1978.

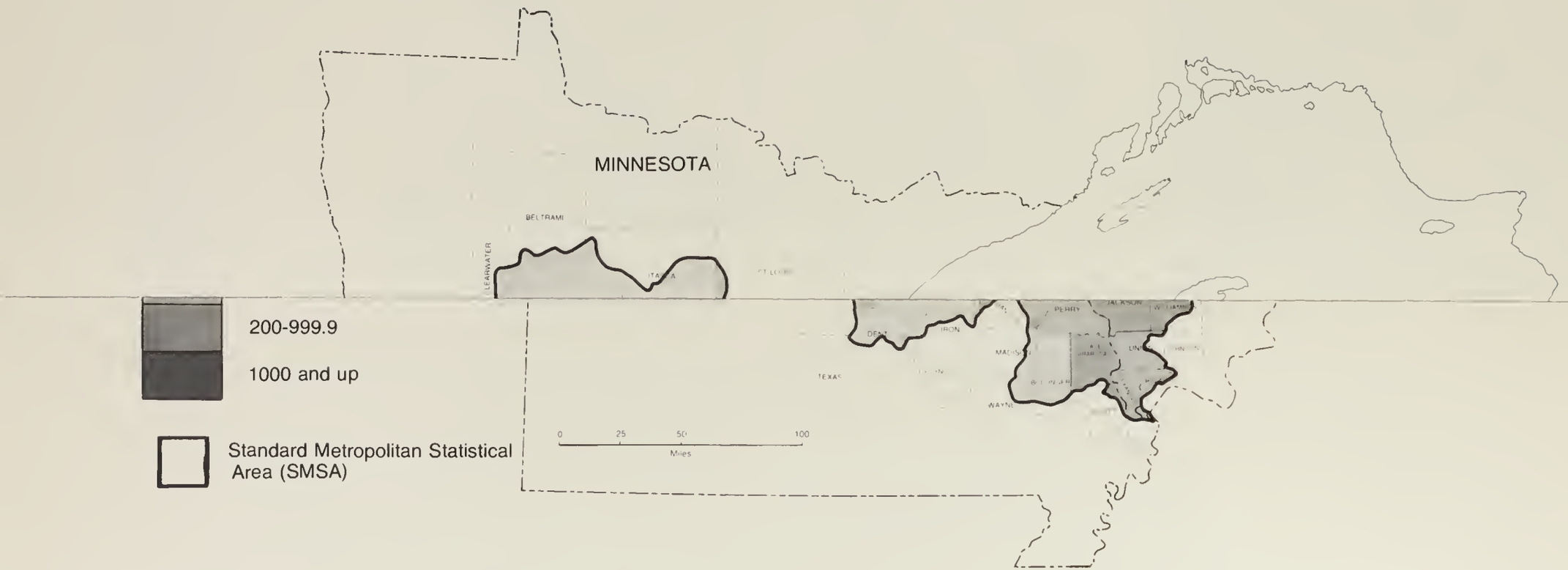

FIGURE I-14. POPULATION DENSITY BY COUNTY, UPPER MISSISSIPPI REGION

Sources: U.S. Department of Commerce, Bureau of the Census, *Final Population and Housing Counts,* Illinois, March 1981; Indiana, March 1981; Iowa, March 1981; Missouri, March 1981; South Dakota, March 1981.
U.S. Department of Commerce, Bureau of the Census, *Preliminary Report on Population,* Minnesota, February 1981; Wisconsin, February 1981.
U.S. Department of Commerce, Bureau of the Census, *Standard Metropolitan Statistical Areas,* December 1977, (map).

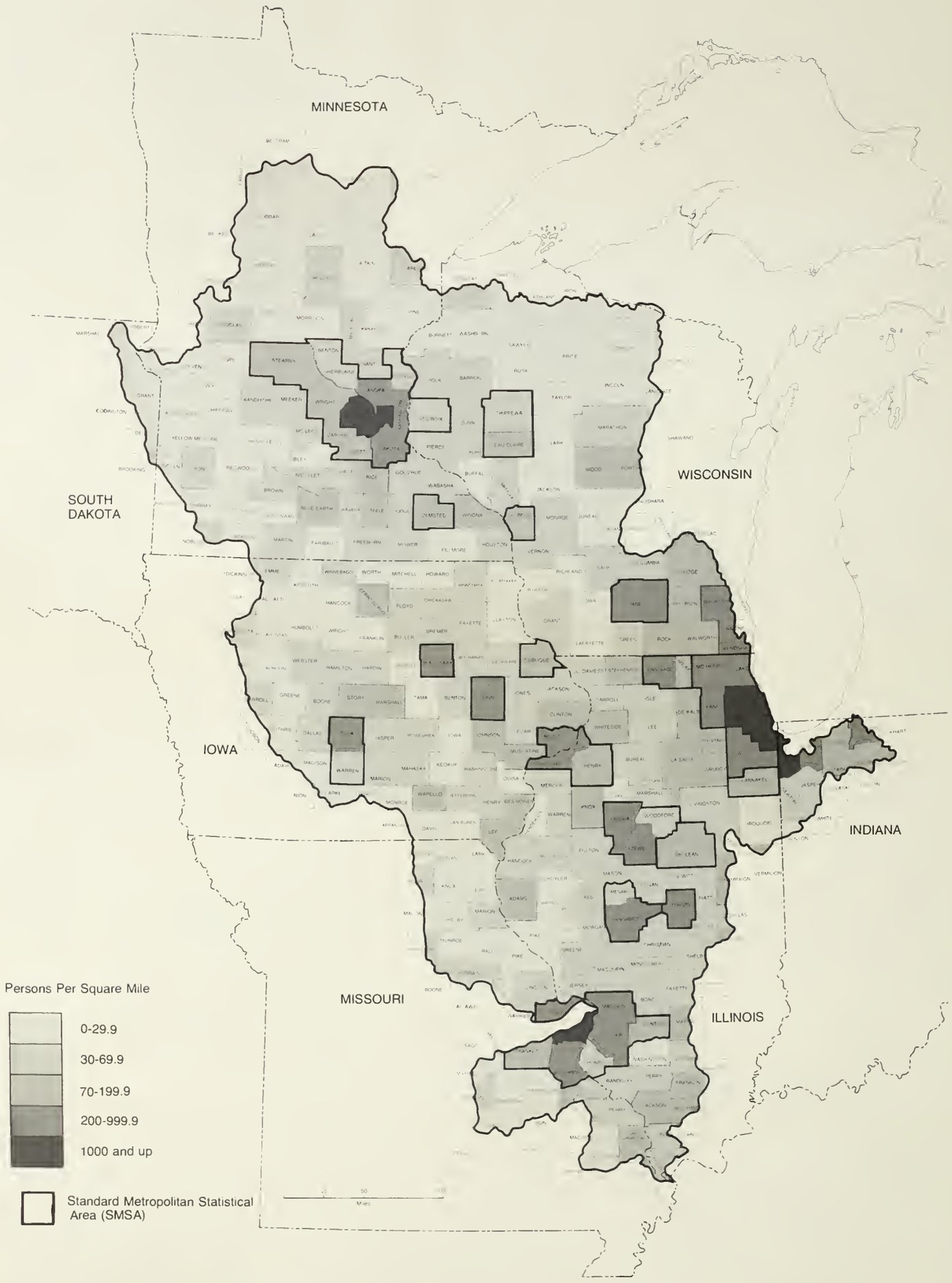

FIGURE I-14. POPULATION DENSITY BY COUNTY, UPPER MISSISSIPPI REGION

Sources: U.S. Department of Commerce, Bureau of the Census, *Final Population and Housing Counts,* Illinois, March 1981; Indiana, March 1981; Iowa, March 1981; Missouri, March 1981; South Dakota, March 1981.
U.S. Department of Commerce, Bureau of the Census, *Preliminary Report on Population,* Minnesota, February 1981; Wisconsin, February 1981.
U.S. Department of Commerce, Bureau of the Census, *Standard Metropolitan Statistical Areas,* December 1977, (map).

ted with earnings more than doubling by 2000. Illinois will retain its largest share of earnings with 56 percent of the regional total (Figure I-15). Ranking subregions by earnings is also identical to the ranking by population (Table I-5).

Manufacturing has the largest employee earnings of any industry with almost one-third of the total current earnings (Figure I-16). Machinery, electrical machinery, food and kindred products, fabricated metals, and printing and publishing industries account for 60 percent of manufacturing earnings. In almost all areas, however, manufacturing will have a smaller employment share as productivity improves and consumer expenditures shift toward services. All major industries will have larger future earnings but growth in services, manufacturing, and government is projected to be the largest. Agricultural earnings will rise but not as rapidly as other industries. The market value of agricultural products in the region was approximately $13.3 billion (1974 dollars) in 1974 of which half was for livestock, poultry, and their products.[8]

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[8]U.S. Department of Commerce, Bureau of the Census, Census of Agriculture, 1974.

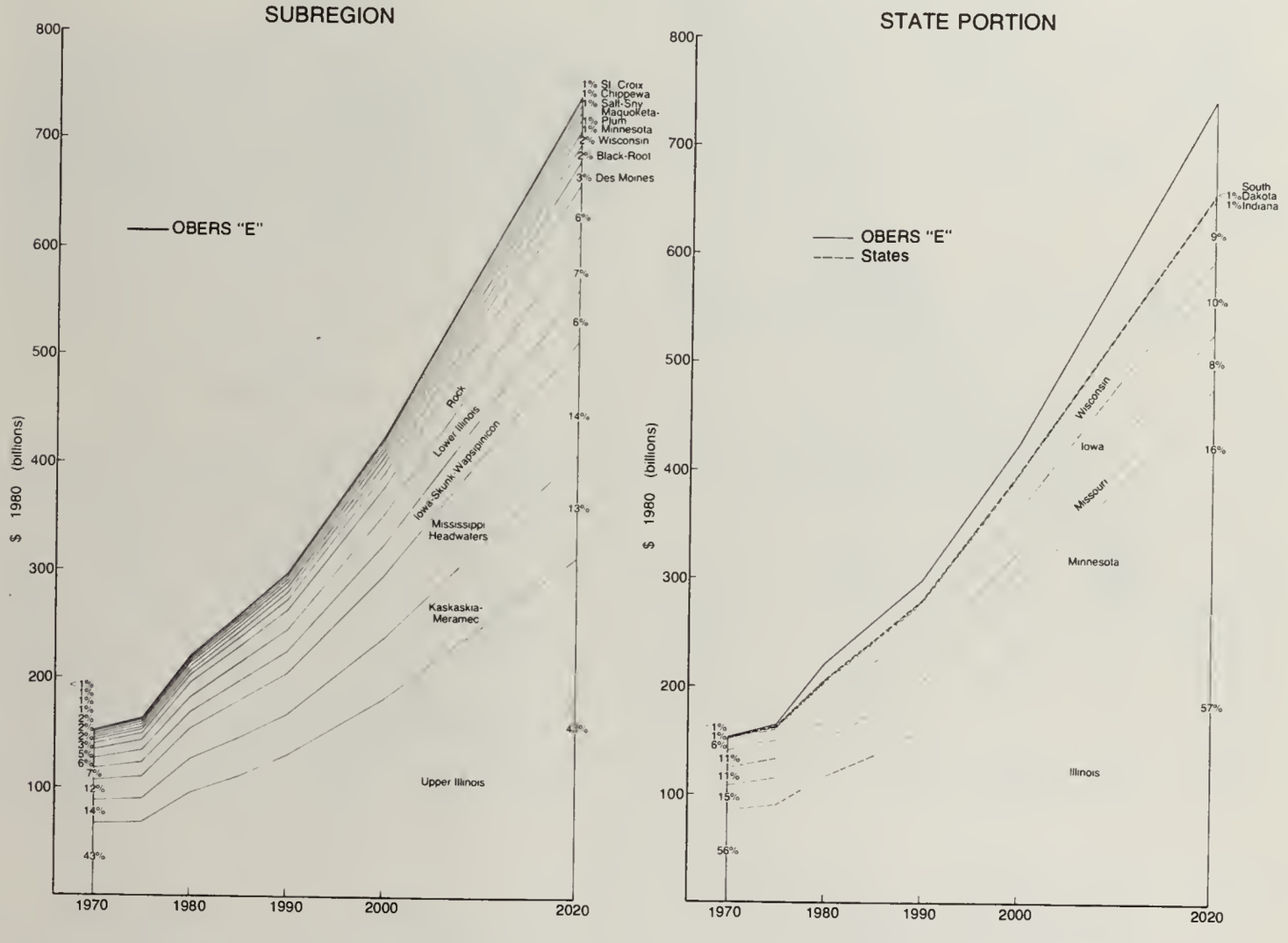


FIGURE I-15. EARNINGS PROJECTION TO 2020, UPPER MISSISSIPPI REGION

Source: UMRBC, Socio-Economic Information System (OBERS "E" — 1972, OBERS "E" — States), July 1978.

TABLE I-5. EMPLOYMENT AND EARNINGS, UPPER MISSISSIPPI REGION

	1970		1975		1980		1990		2000	
	OBERS "E"	States	OBERS "E"	States	OBERS "E"	States	OBERS "E"	States	OBERS "E"	States
TOTAL EMPLOYMENT (millions)										
Upper Mississippi Region	8.9	8.9	9.4	9.3	10.3	9.7	11.2	10.4	12.3	11.6
Illinois Portion	4.74	4.74	4.92	4.89	5.28	4.91	5.75	5.31	6.32	6.08
Indiana Portion	0.06	0.06	0.06	0.06	0.07	0.06	0.07	0.07	0.07	0.07
Iowa Portion	1.01	1.01	1.09	1.10	1.16	1.17	1.22	1.25	1.29	1.34
Minnesota Portion	1.39	1.39	1.56	1.54	1.73	1.65	1.96	1.78	2.19	1.88
Missouri Portion	0.99	0.99	1.01	0.97	1.17	1.00	1.25	0.98	1.34	1.07
South Dakota Portion	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Wisconsin Portion	0.71	0.71	0.78	0.75	0.86	0.86	0.94	0.97	1.03	1.10
TOTAL EARNINGS (billions of 1980 dollars)										
Upper Mississippi Region	147.4	147.4	159.3	157.4	216.9	202.8	298.4	274.0	417.0	387.96
Illinois Portion	83.4	83.4	89.1	88.3	122.5	113.9	167.9	154.5	235.9	226.2
Indiana Portion	1.0	1.0	1.0	1.0	1.2	1.2	1.7	1.7	2.2	2.2
Iowa Portion	14.6	14.6	17.1	17.3	20.7	20.7	27.6	28.3	37.1	38.8
Minnesota Portion	22.4	22.4	24.9	24.4	34.2	32.5	49.0	44.2	69.5	59.3
Missouri Portion	16.3	16.3	16.6	16.1	23.7	20.0	31.7	24.6	43.2	31.0
South Dakota Portion	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2
Wisconsin Portion	9.5	9.5	10.5	10.5	14.4	14.4	20.5	21.0	28.8	30.3

Source: UMRBC, Socio-Economic Information System (OBERS "E"-1972, OBERS "E"-States), July 1978.

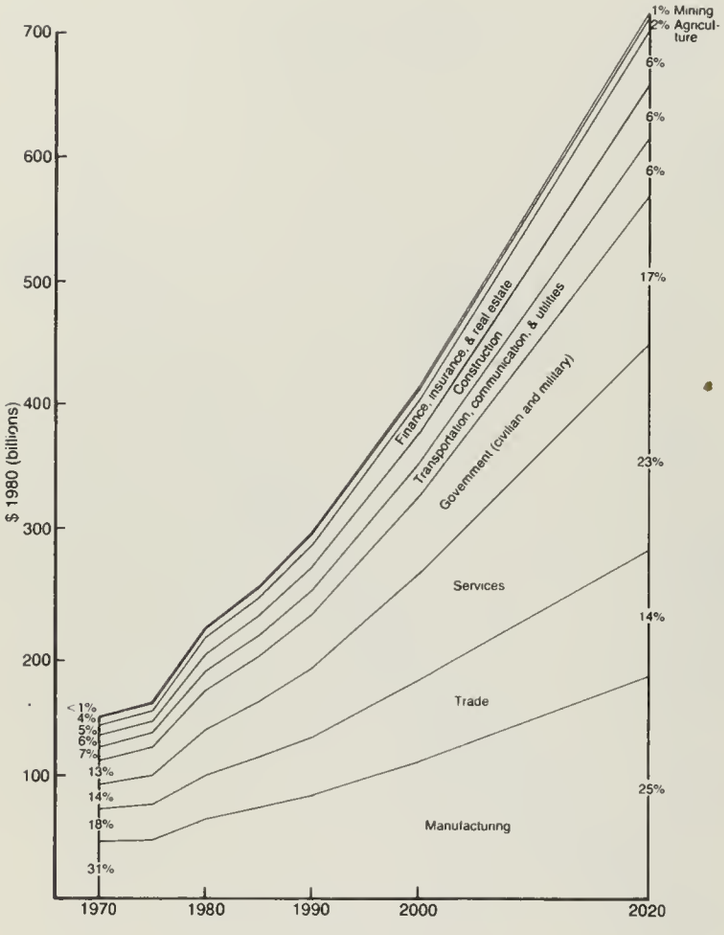
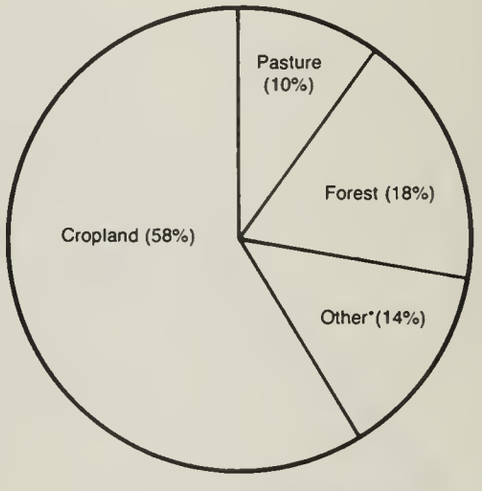


FIGURE I-16. EARNINGS BY MAJOR INDUSTRIES, UPPER MISSISSIPPI REGION

Source: UMRBC, Socio-Economic Information System (OBERS "E" — 1972, OBERS "E" — States), July 1978.

Land Use

A suitable climate and excellent soil and water resources have made agricultural crop production the primary land use throughout most of the region (Figure I-17). In central Illinois, Iowa, and southwestern Minnesota, over 70 percent



Total Land Area (116,264,000 acres)

*Other land includes rural land, urban land, and federal land

FIGURE I-17. LAND USE IN 1979, UPPER MISSISSIPPI REGION

Sources: U.S. Department of Agriculture, Soil Conservation Service, *1967 Conservation Needs Inventory.*
U.S. Department of Agriculture, *Soil and Water Resources Conservation Act: 1980 Appraisal, Part II,* 1980. (review draft)
U.S. Department of Commerce, Bureau of the Census, *Census of Agriculture,* 1974.

of the total area is in row crops. Although the total land in farms has declined since 1950, the land used for crops has risen nominally.[9] Marginal cropland that previously was pastureland, woodland, or wetland has been increasingly cultivated. The average farm size has increased from about 150 acres to 225 acres while the national average doubled to 400 acres.

Only in the north is cropland a secondary land use to forest (Figure I-18). The climate and soil in the north limit agricultural development and most land has remained forested. Recreation, forestry, and mining dominate use of the land resources in this area. Most large federal land holdings are in the north within the Chequamegon, Chippewa, and Nicolet National Forests. Other major federal land holdings are the Mark Twain and Shawnee National Forests in the south.

Land use patterns have slow continual changes that may not be apparent at the regional level. Urbanization is infringing on cropland and forests, at the same time as agriculture is absorbing former pasture, forest, and drained wetland areas. Any shifts in the land use of the region will likely occur in forestland and pastureland, in addition to cropland.

Agriculture

Farming in the region is undergoing changes in farm size, ownership, and specialization similar to the entire nation. Farm numbers have dropped about 45 percent in the 30 years since 1950.[10] As farm numbers declined, total land in farms has decreased slightly. However, land used for crops has risen as farmers cultivate and crop a larger share of their farms. A shift to greater mechanization, which increased crop production per hour of labor, triggered a decrease in the number of small farms and an increase in the number of larger farms with greater cultivated acreages.

Real estate values have soared in the region, as earnings increased and the prospects for farm income remained good. The average value of farm real estate in Minnesota, Iowa, and Illinois increased over 300 percent between March 1970 and February 1979--the highest increases in the nation.[11] Land values have exceeded the inflation rate by a significant amount encouraging land speculation and less owner operators. In 1974, approximately 40 percent of the farmland was rented and this figure continues to rise.

Farms have become more specialized because of increased farm size, increased agricultural exports, improved farm machinery, and greater fertilizer application. In the past, most every farm produced a diversity of crops and managed several species of livestock. Now individual farms often produce only one crop, corn or soybeans, without secondary crops or livestock. Corn is the primary regional crop, and soybeans, hay, and oats the other main crops (Table I-6). Crop receipts for the region have

[9]U.S. Department of Agriculture, Another Revolution in Farming? by Lyle P. Schertz, et. al., 1979.

[10]U.S. Department of Agriculture, op. cit., footnote 9.

[11]U.S. Department of Agriculture, Farmline (Vol. 1, No. 1), April 1980.

TABLE I-6. CROP ACREAGE AND PRODUCTION, UPPER MISSISSIPPI REGION

	All Farms		Farms Class 1-5[a]	
	Acreage (thousands)	Production (thousands)	Acreage (thousands)	Production (thousands)
Corn	26,259	NA	26,107	NA
for grain	NA	NA	23,707	1,868,579 bu.
for silage	NA	NA	2,305	24,551 tons
Sorghum	168	NA	162	NA
for grain	NA	NA	128	4,918 bu.
Wheat	2,411	72,443 bu.	2,374	71,820 bu.
Oats	NA	NA	3,313	179,320 bu.
Barley	NA	NA	96	3,614 bu.
Rye	NA	NA	69	1,613 bu.
Other Small Grain	3,716	NA	NA	NA
Hay or Grass Silage	7,978	19,563 tons	7,793	19,440 tons
Soybeans for beans	15,738	397,519 bu.	15,790	396,734 bu.
Vegetables for sale	470	NA	466	NA
Orchards	29	NA	25	NA
Tobacco	8	9 tons	8	9 tons
Potatoes	64	NA	62	NA

[a]Farms with sales of $ 2,500 and over.
Source: U.S. Department of Commerce, Bureau of the Census, Census of Agriculture, 1974.

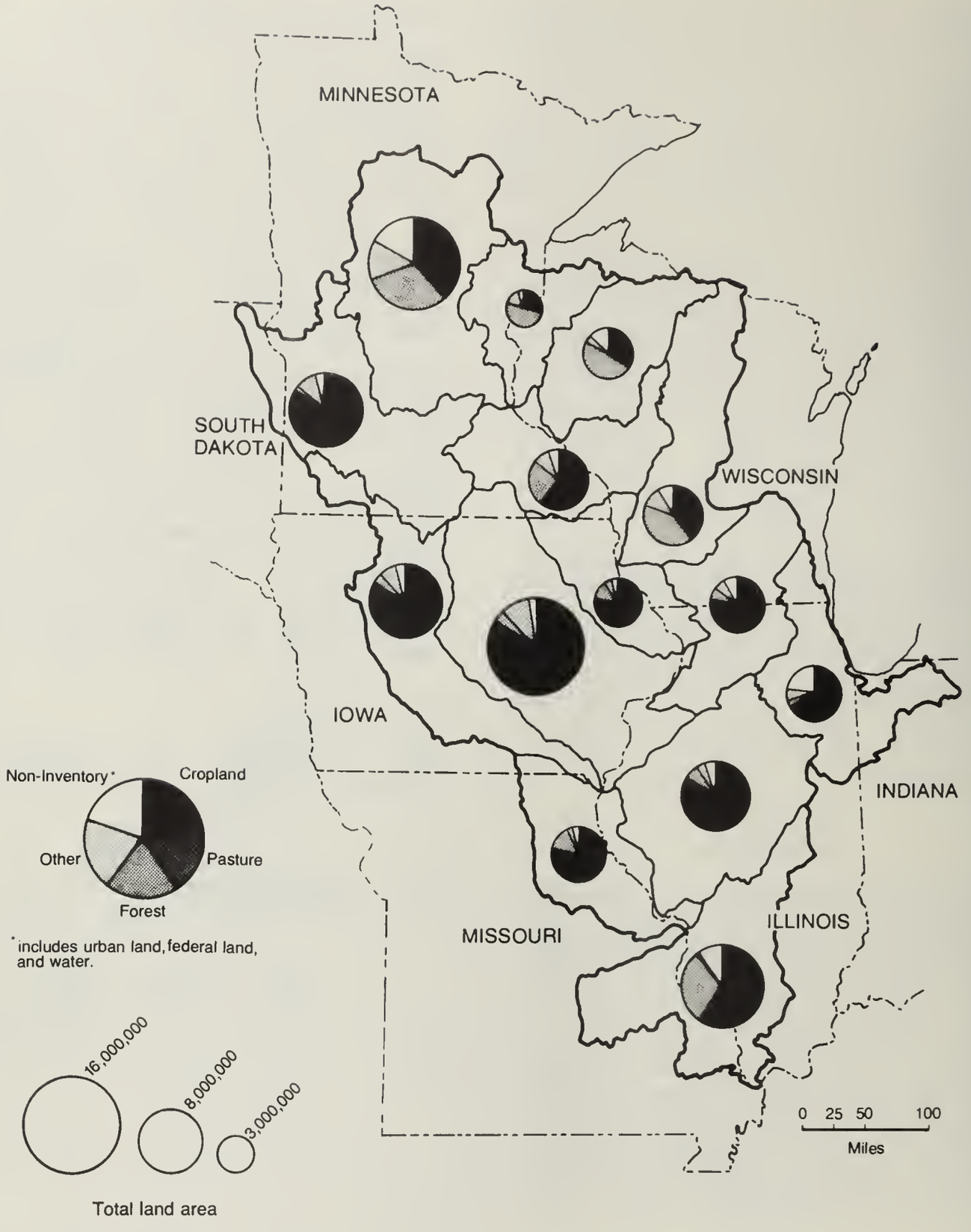


FIGURE I-18. LAND USE, SUBREGIONS OF THE UPPER MISSISSIPPI REGION

Sources: U.S. Department of Agriculture, Soil Conservation Service, *1967 Conservation Needs Inventory.*
U.S. Department of Agriculture, Soil Conservation Service, *1977 National Resources Inventory,* 1979. (unpublished data)
U.S. Department of Commerce, Bureau of the Census, *Census of Agriculture,* 1974.

increased from 30 percent of total crop and livestock receipts in the early 1960s to 50 percent in the mid-1970s.[12]

The dramatic increase of agricultural exports in the 1970s has accelerated crop production and specialization. Corn and soybean exports have been particularly large among the many farm products increasingly exported from the region. The growth in corn and soybean exports have affected their prices, encouraging production of these commodities over application of government programs that restrict the acreage harvested.

Inflation, energy prices, and changes in tax laws could alter current agriculture land ownership and cropping characteristics. However, the trend in declining farm numbers and increasing farm size should continue. A further separation of the ownership and use of land is also probable.

Navigation

The Upper Mississippi River System links the Great Lakes and the Gulf of Mexico and provides an essential avenue for exporting grain from this region and for importing and distributing coal and petroleum (Figure I-19). The navigable waterways in the river system comprise the Mississippi River from Minneapolis to Cairo (miles 0-853.7); the Illinois Waterway which includes the Illinois River, Des Plaines River, Chicago Sanitary and Ship Canal, South Branch Chicago River, Chicago River, Calumet-Sag Channel, and the Little Calumet and Calumet Rivers; the Minnesota River (miles 0-25.6); the St. Croix River (miles 0-24.5); the lower 1.4 miles of the Black River; and the lower 36 miles of the Kaskaskia River (Figure I-20). Improvement to the river system for navigation includes a channel allowing for a 9-foot draft, 38 locks and dams, commercial and recreational boat harbors, barge fleeting areas, and terminals (Table I-7). Dredging of the bottom sediment in the Mississippi, Kaskaskia, Minnesota, and St. Croix rivers and Illinois Waterway is necessary at some locations to maintain sufficient depth for navigation.

In 1977, commodity movement between Minneapolis and the mouth of the Missouri River totalled 67 million short tons; 74 million short tons were moved between the mouth of the Missouri and Ohio rivers and 41 million on the Illinois River (Figure I-21). Downbound traffic is slightly greater than upbound with grain as the primary commodity. Upbound commerce consists of coal, petroleum, and fertilizers.

Commodity movement is projected to rise substantially throughout the navigation system (Figure I-22). Between 1980 and 2000 commodity movement on the Mississippi River is projected to increase 69 percent from Minneapolis to the Missouri River and 80 percent from the Missouri River to the Ohio River. Commodity movement on the Illinois River could increase 49 percent.[13] These projections assume no constraints to traffic growth within the navigation system.

Recreation

Swimming, picnicking, and fishing were surveyed to be the most popular activities in the region and are expected to increase their popularity over the other activities--camping, boating, and waterskiing where gradual growth in participation is projected; and canoeing and waterfowl hunting which have the least participation (Figure I-23).

For all the subregions, the relative amount of participation correlated closely with their population ranking in the region (Table I-8). The largest participation for most of the activities occurred in the Upper Illinois, the Kaskaskia-Meramec, and the Mississippi Headwaters subregions and the least participation occurred in the St. Croix, Chippewa, and the Minnesota subregions.

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[12]U.S. Department of Agriculture, State Farm Income Statistics, Supplement to Statistical Bulletin No. 609, September 1978.

[13]U.S. Army Corps of Engineers, National Waterways Study, Traffic Forecasting Methodology and Demand Projections, April 1980. (review draft).

FIGURE I-19. TOTAL COMMODITY MOVEMENT IN 1976, UPPER MISSISSIPPI RIVER SYSTEM

Source: U.S. Department of the Army, Corps of Engineers, *Total Commodity Movement By Water: 1976, (National Waterways Study)*, 1980. (map)

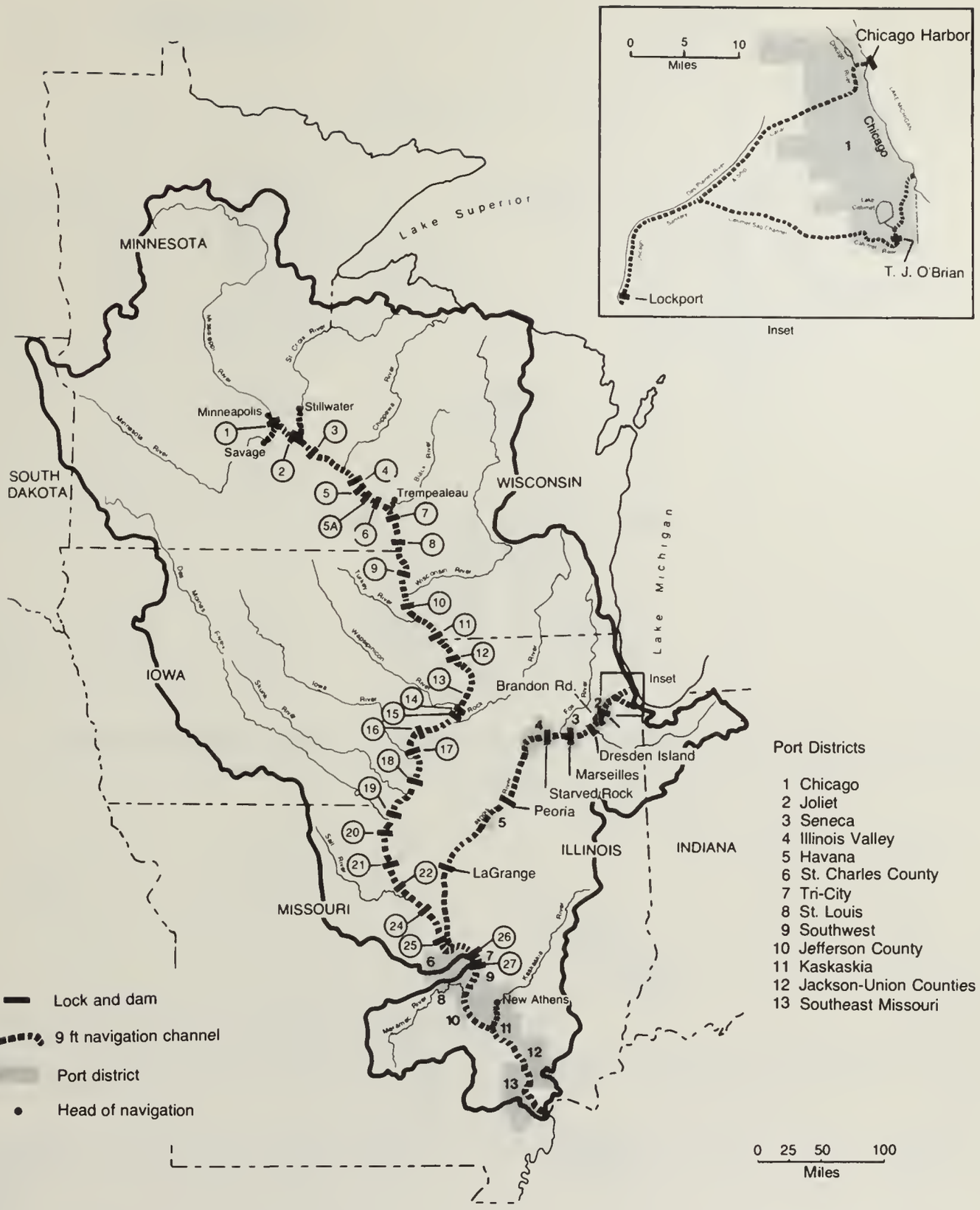


FIGURE I-20. UPPER MISSISSIPPI RIVER NAGIVATION SYSTEM

Sources: Illinois Department of Transportation, Division of Water Resources, *Directory of Regional Port Districts in Illinois*, July 1978.
U.S. Department of the Army, Corps of Engineers, *Water Resources Development in Iowa*, 1979; *Water Resources Development in Illinois*, 1979; *Water Resources Development in Minnesota*, 1979; *Water Resources Development in Missouri*, 1979; *Water Resources Development in Wisconsin*, 1979.

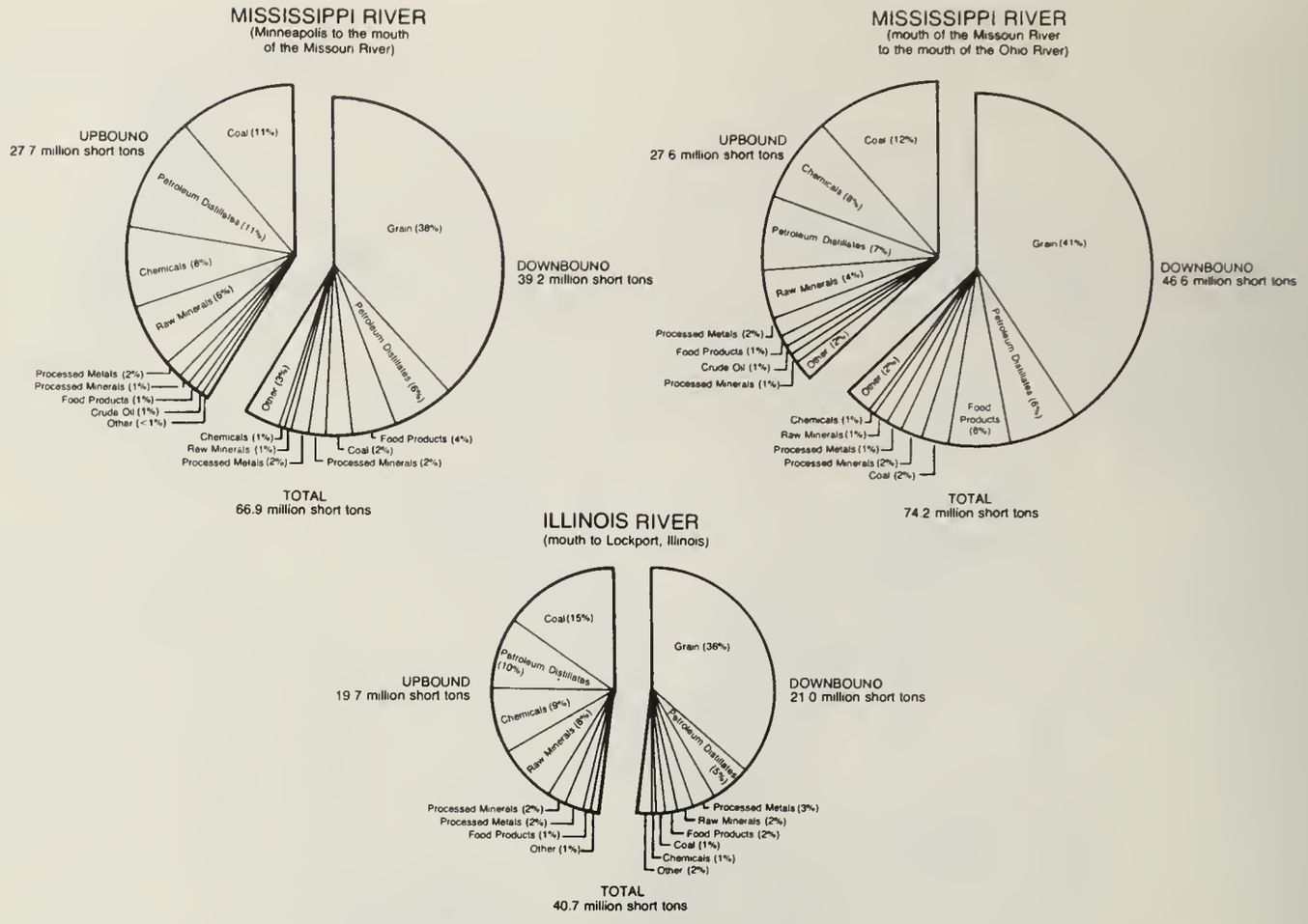


FIGURE I-21. NAVIGATION COMMERCE IN 1977 BY COMMODITY, UPPER MISSISSIPPI REGION

Source: U.S. Department of the Army, Corps of Engineers, *Waterborne Commerce of the United States,* (Part 2), 1977.

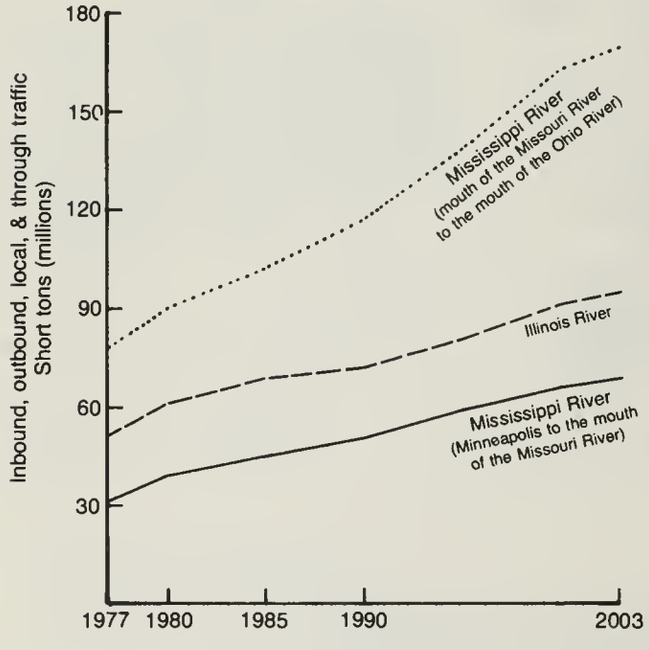


FIGURE I-22. WATERBORNE COMMODITY MOVEMENT TO 2003*, UPPER MISSISSIPPI REGION

*Projections based on unconstrained demand for Mississippi and Illinois River traffic.

Source: U.S. Army Corps of Engineers, *National Waterways Study, Traffic Forecasting Methodolory and Demand Projection,* April 1980. (review draft)

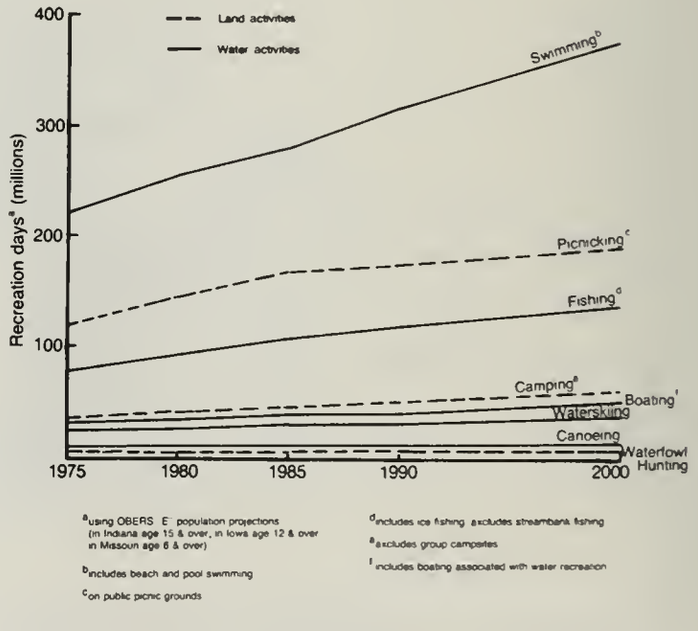


FIGURE I-23. SELECTED ANNUAL RESIDENT WATER AND RELATED RECREATION, TRENDS TO 2000, UPPER MISSISSIPPI REGION

Sources: UMRBC, Recreation Forecasts, December 1978 — adjusted May 1980 (for projection methodology consult the Recreation Section of the *Reference Handbook*).

TABLE I-7. PHYSICAL CHARACTERISTICS OF THE NAVIGATION CHANNEL, UPPER MISSISSIPPI REGION

Lock	Mile	Lock Size (feet)	Depth Over Sill, (feet)	Lift (feet)	Recreational Pool (thousand acres)	Controlling Clearances Horizontal (feet)	Controlling Clearances Vertical (feet)	Terminals	Boat Harbors	Boat Launching Acres
			UPPER MISSISSIPPI RIVER							
Lock No. 27	185-202.9	110 x 1200, 110 x 600	16.0	8.0				21	2	4
Lock No. 26	202.9-241.4	110 x 600, 110 x 360	13.5	23.0	28.1	No bridges	55.2	16	19	37
Lock No. 25	241.4-273.4	110 x 600	12.0	15.0	18.0	No bridges or aerial wires		3	2	12
Lock No. 24	273.4-301.2	110 x 600	12.0	15.0	14.0	195.4	55.0	2	4	4
Lock No. 22	301.2-324.9	110 x 600	13.5	10.2	8.8	159.8	53.1	8	0	3
Lock No. 21	324.9-343.2	110 x 600	12.0	10.5	9.6	300.0	50.4	14	0	2
Lock No. 20	343.2-364.2	110 x 600	12.0	10.0	7.9	158.0	59.6	12	0	1
Lock No. 19	364.2-410.5	110 x 1200	13.0	38.0	33.5	153.0	53.5	16	0	0
Lock No. 18	410.5-437.1	110 x 600	13.7	9.8	13.9	224.0	54.2	6	0	1
Lock No. 17	437.1-457.2	110 x 600	13.0	8.0	6.6	427.6	51.0	8	0	2
Lock No. 16	457.2-482.9	110 x 600	12.0	9.0	13.0	198.3	49.3	15	0	3
Lock No. 15	482.9-493.3	110 x 600, 110 x 360	11.0	16.0	3.7	710.0	62.8	17	0	0
Lock No. 14	493.3-522.5	110 x 600, 80 x 320	13.5	11.0	9.2	202.5	60.0	16	0	6
Lock No. 13	522.5-556.7	110 x 600	13.6	11.0	30.4	159.5	57.0	4	0	5
Lock No. 12	556.7-583.0	110 x 600	13.0	9.0	13.0	151.8	50.3	15	0	6
Lock No. 11	583.0-615.1	110 x 600	12.5	11.0	21.0	No bridges	68.1	8	0	3
Lock No. 10	615.1-647.9	110 x 600	12.0	8.0	3.2	239.0	55.6	11	6	29
Lock No. 9	647.9-679.2	110 x 600	13.0	9.0	15.4	620.0	55.3	10	3	21
Lock No. 8	679.2-702.5	110 x 600	14.0	11.0	11.6	150.0	55.2	6	2	18
Lock No. 7	702.5-714.3	110 x 600	12.0	8.0	8.3	No bridges or aerial wires		3	0	21
Lock No. 6	714.3-728.5	110 x 600	12.5	6.5	2.7	151.0	51.5	13	0	26
Lock No. 5A	728.5-738.1	110 x 600	12.5	5.5	6.7	No bridges or aerial wires		3	0	10
Lock No. 5	738.1-752.8	110 x 600	12.0	9.0	13.7	No bridges	75.1	3	0	10
Lock No. 4	752.8-796.9	110 x 600	13.0	7.0	33.1	406.7	52.2	17	5	29
Lock No. 3	796.9-815.2	110 x 600	14.0	8.0	5.9	106.0	50.1	5	1	7
Lock No. 2	815.2-847.6	110 x 600, 110 x 500	13.0	12.2	4.0	158.0	40.7	18	6	12
Lock No. 1	847.6-853.4	56 x 400, 56 x 400	10.0	37.9	0.6	188.0	53.0	--	--	--
Lower St. Anthony	853.4-853.7	56 x 400	12.3	24.9	--	56.0	24.4	--	--	--
Upper St. Anthony	853.7-	56 x 400	13.7	49.2	--	139.3	21.4	--	--	--
			ILLINOIS WATERWAY							
La Grange	80.2-157.7	110 x 600	13.0	10.0	NA	110.5	47.9	25	0	12
Peoria	157.7-231.0	110 x 600	12.0	11.0	NA	118	40.0	27	3	29
Starved Rock	231.0-244.6	110 x 600	14.0	18.7	NA	167	37.8	8	0	8
Marseilles	244.6-271.5	110 x 600	14.0	24.25	NA	113.6	34.9	10	1	6
Oresden Island	271.5-286.0	110 x 600	12.3	21.75	NA	110	45.9	8	0	3
Brandon Road	286.0-291.1	110 x 600	13.8	34.0	Channel	150	50.2	12	0	0
Lockport Lock	291.1-326.5	110 x 600	11.5	30-42	Channel	80	17.0	67	0	16
O'Brien Lock	326.5-	110 x 600	14.0	0.2	Channel	49.3	18.4	--	--	--

TRIBUTARY CHANNELS

River	Mile	Number of Locks/ Lock Size (feet)	Width of Channel (feet)	Depth of Channel (feet)	Dredging Required
Minnesota River	Mouth to mile 21.8 (Savage)	none	100	9	intermittent
	Mile 21.8 to 25.6 (Shakopee)	none	--	4	none
Saint Croix River	Mouth to mile 24.5 (Stillwater)	none	--	9	yes
	Mile 24.5 to Taylors Falls	none	--	3	none
Black River	Mouth to Mile 1.4	none	300	9	none
Kaskaskia River	Mouth to Mile 36 (New Athens)	1/84 x 600	225	9	yes

Sources: UMRCBS Coordinating Committee, Upper Mississippi River Comprehensive Basin Study, (Vol. V), 1970.
U.S. Army, Corps of Engineers, Water Resources Development in Illinois, 1979.
U.S. Army, Corps of Engineers, Water Resources Development in Minnesota, 1979.
U.S. Army, Corps of Engineers, Water Resources Development in Wisconsin, 1979.

TABLE I-8. POPULARITY OF WATER RECREATION ACTIVITIES, UPPER MISSISSIPPI REGION

in thousand recreation days[a]

	Boating		Canoeing		Swimming		Water Skiing		Fishing		Camping		Picnicking		Waterfowl Hunting	
	1980	2000	1980	2000	1980	2000	1980	2000	1980	2000	1980	2000	1980	2000	1980	2000
Upper Mississippi Region	35526	50278	6431	9170	252521	372839	29097	37443	93077	134667	39840	57489	144976	191202	3403	4146
Subregions																
Mississippi Headwaters	978	1195	280	352	15596	19168	7168	9097	8950	11288	2427	3108	5131	6547	855	1083
Minnesota	173	141	45	49	2609	2762	1157	1256	1490	1606	419	467	838	921	152	166
Saint Croix	120	132	25	28	512	554	145	160	222	243	101	110	364	398	25	26
Black-Root	662	741	148	167	3669	4071	1253	1416	1763	1983	676	766	2155	2435	190	206
Chippewa	511	545	107	114	1574	1680	310	331	576	615	345	368	1422	1518	76	74
Maquoketa-Plum	805	1013	109	118	2159	2671	610	657	1528	2053	831	1129	1520	1657	54	56
Wisconsin	1001	1121	210	235	3083	3451	608	681	1129	1264	677	757	2785	3118	149	153
Iowa-Skunk-Wapsipinicon	4395	5725	556	608	12224	15617	3633	3964	9094	12492	4821	6734	8006	8926	275	297
Rock	2295	3039	385	490	12444	18040	1408	1847	3940	5582	2035	2814	9462	12342	263	295
Des Moines	2219	2916	287	313	4630	5794	1826	1990	4379	6107	2383	3383	3033	3305	136	148
Salt-Sny	662	957	209	311	5149	7445	242	338	1690	2448	634	910	2157	2869	40	56
Upper Illinois	11020	16093	942	1383	103414	158137	6540	9390	30720	45895	13873	20539	69499	92220	546	631
Lower Illinois	1956	2902	169	252	19521	29924	1225	1766	5599	8480	2537	3798	13166	17473	94	110
Kaskaskia-Meramec	8729	13708	2959	4750	65937	103525	2972	4552	21997	34611	8081	12606	25438	37473	548	845

[a]Recreation day =activity participation rate x population set. For complete details of the projection methodology consult the Recreation section in the Reference Handbook.

Source: UMR8C-CCJP, Recreation Forecasts, December 1978.

OFFSTREAM WATER USE

The availability of water resources can restrict water used for domestic, industrial, and agricultural purposes. Since water resources are generally abundant throughout the Upper Mississippi Region, water supply has seldom influenced the siting of major water-using enterprises. Municipalities and industries have located primarily for economic advantages not for water supply. As demands rise and as other water quality and instream flow needs of water are recognized, water allocation regulations may dictate a greater consideration and planning for water availability and use.

Rising water costs should encourage conservation by individuals and industries. Domestic water use, which includes residential and commercial water use, in addition to delivery losses, fire protection, street washing, and city and park maintenance, could increase at a rate similar to the population without more efficient water-saving devices. Manufacturing will increasingly reuse water in processing and transporting industrial products. Techniques for cooling in the manufacturing and energy industries should become less water intensive and will include fewer once-through cooling plants and more wet and dry cooling towers and recycling systems. Farmers are also likely to improve their irrigation distribution and application systems to minimize pumping costs. These innovations and better management practices will help minimize water withdrawal, but water consumption will rise significantly.

TABLE I-9. DOMESTIC WATER USE TO 2020, UPPER MISSISSIPPI REGION

Projection Data Base	1975	1980	1985	1990	2000	2020
	WATER WITHORAWAL in million gallons per day (MGO)[a]					
OBERS "E"	2054	2173	2296	2412	2615	2928
States	2049	2134	2245	2357	2597	2766
	WATER CONSUMPTION (MGO)					
	1975	1980	1985	1990	2000	2020
OBERS "E"	623	658	693	726	781	856
States	622	646	676	710	772	811
	WATER WITHORAWAL WITH CONSERVATION[b] (MGD)					
	1975	1980	1985	1990	2000	2020
OBERS "E"	2054	2173	2184	2182	2139	2397
States	2049	2134	2131	2132	2124	2264

[a]Withdrawal is that amount taken from a surface water or groundwater source. Consumption refers to that portion of withdrawn water not available for reuse.

[b]Per capita water withdrawal reduced 1% per year between 1980-2000.

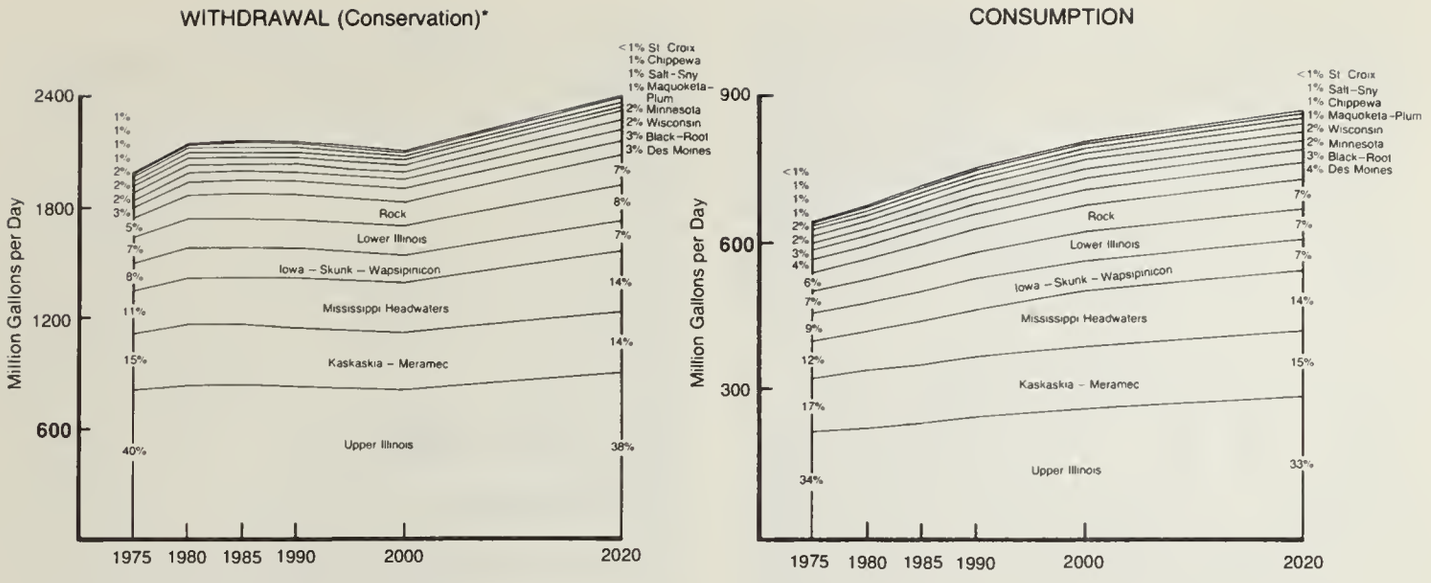
Source: UMRBC, Socio-Economic Information System (OBERS "E" - 1972, OBERS "E" - States), July 1978.

Domestic

Domestic water requirement in the Upper Mississippi Region are approximately 2.1 billion gallons per day (BGD) and may approach 3 BGD by 2020 unless the population growth is less than projected or water conservation is adopted (Table I-9). Current domestic water withdrawal is about 3 percent of total withdrawals, whereas consumption by domestic uses is nearly one-third of all water consumed. Domestic water needs are largest in three river basins: the one with the metropolitan area of Chicago, the one with St. Louis, and the one with Minneapolis-St. Paul (Figure I-24). Forty percent of domestic withdrawal occurs in the Upper Illinois basin; and the Kaskaskia-Meramec and Mississippi Headwaters basins together account for an additional 27 percent.

Central water systems, which distribute water from a major supply source, are used by most residents in the region. Per capita water use is greater with central systems because delivery losses, fire protection, street washing, city maintenance, as well as other miscellaneous uses are included in the average. Lawn care, swimming pools, and air conditioning are also more common in urban areas with municipal systems. Less than 75 percent of the population of the St. Croix, Minnesota, Maquoketa-Plum, Chippewa, Wisconsin, and Black-Root basins are connected to central water systems. Central systems are more prevalent in the southern portions of the region where local groundwater supplies are often unreliable. The demand for better quality drinking water will encourage further expansion of central water systems.

The degree of implementation of water conservation programs will vary throughout the region because of dif-



*Per capital withdrawal reduced 1% per year between 1980 and 2000

FIGURE I-24. DOMESTIC WATER USE TO 2020 BY SUBREGION, UPPER MISSISSIPPI REGION

Source: UMRBC, Socio-Economic Information System (OBERS "E" — 1972), July 1978.

ferences in the cost of water. With only a few available local incentives conservation will occur at a slower rate than in other areas of the nation. Chicago is the only metropolitan area that has established local conservation programs. As a result of a 1967 U.S. Supreme Court decision, water suppliers that desire a Lake Michigan water allocation must develop a conservation plan.

Manufacturing

Food, paper, chemical, petroleum and coal, and primary metals industries are the five major water-using industries (Table I-10). Manufacturing requires water for cooling, and for processing and transporting industrial products or byproducts. Cooling water, which is the largest requirement, is used to condense

TABLE I-10. WATER USE CHARACTERISTICS FOR MANUFACTURING TO 2000, UPPER MISSISSIPPI REGION

WATER USE in million gallons per day (MGD)

	Food and Kindred Products	Paper and Allied Products	Chemicals	Petroleum and Coal Products	Primary Metals	Other Manufacturing	Total
1975							
Gross Water Use	852	590	950	1207	2652	852	7103
Withdrawal	552	388	430	189	1940	466	3965
Consumption	63	23	46	36	138	43	349
1985							
Gross Water Use	1166	978	2058	2137	3159	1335	10,833
Withdrawal	255	165	187	111	543	219	1480
Consumption	91	48	78	64	168	66	515
2000							
Gross Water Use	1500	1492	3627	2813	3708	2083	15,223
Withdrawal	164	123	151	85	312	222	1057
Consumption	131	100	122	59	260	103	775

Gross Water Use = Withdrawal x Recirculation Rate

Sources: UMRBC, Socio-Economic Information System (OBERS "E" - 1972), July 1978.
Office of Business Research and Analysis, Industrial Water Use Forecasting Model, 1978.

many products of oil refineries and chemical plants, and to protect industrial equipment from heat. Process water contacts material used for cleaning, cooking, dissolving, or transporting the products or byproducts. Waste byproducts often are transported also from the plant by water. For 1977, manufacturing withdrawal requirements were 3.5 BGD or 22 percent of all withdrawals in the Upper Mississippi Region.

The primary metals industry uses the most water and is concentrated mainly in the Chicago area. Food and kindred products have the second largest water withdrawal but less recirculation than some other industries. The food industry is prevalent throughout the region, but two major production areas are the Upper Illinois and Iowa-Skunk-Wapsipinicon basins. Northern Wisconsin, especially the Wisconsin River Basin, is a paper manufacturing area. Chemical, petroleum, and coal industries are predominantly in the Chicago and St. Louis areas. In the region, the Upper Illinois, Kaskaskia-Meramec, Lower Illinois, and Iowa-Skunk-Wapsipinicon river basins use the most water for manufacturing (Figure I-25).

Future water withdrawals for manufacturing are expected to decline. The Clean Water Act of 1977 requires industry to treat its wastewater to meet certain standards before discharge into local sewer systems or streams and lakes. To meet these standards at minimum costs, industry will either reduce water use or recirculate more water which reduces the amount that must be treated before discharge. Industrial water conservation will cause not only substantial reductions in water withdrawals but also large increases in gross water use and consumption. Gross water use currently is nearly twice water withdrawal in most subregions and consumption is about one-tenth of withdrawal. By 2000, gross water use could be fifteen times greater than withdrawal, and consumption three-quarters of withdrawal.

Actual future water use could differ significantly from projections if implementation of recirculation systems in manufacturing lags because of economic and technological feasibility in addition to government regulation and enforcement. Product quality is a concern unless treatment techniques can remove the wastes accumulated during the recycling process.

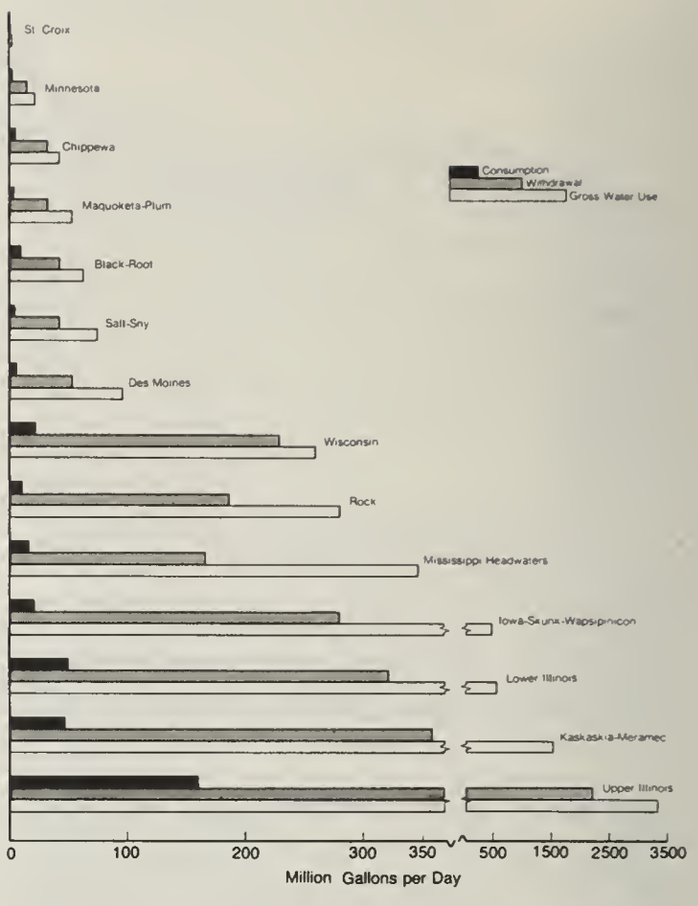


FIGURE I-25. GROSS WATER USE, WITHDRAWAL, AND CONSUMPTION FOR MANUFACTURING IN 1975, UPPER MISSISSIPPI REGION

Sources: Department of Commerce, Office of Business Research and Analysis, *Industrial Water Use Forecasting Model*, 1975. UMRBC, Socio-Economic Information System (OBERS "E" — 1972, OBERS "E" — States), July 1978.

Mining

The ability of water to dissolve, suspend, and transport makes it an essential tool in the mineral industry. Mining needs are only 2 percent of total regional water withdrawals, but have a significant effect on local supplies. Water use is highly variable within the industry; some mining operations require more water to produce minerals than others. Mineral processing changes will influence future mineral water requirements and present projections.

Dimension stone processing, the primary mining water use throughout the region, is particularly concentrated in the Lower Illinois, Upper Illinois, Kaskaskia-Meramec, Wisconsin, and Rock river basins (Table I-11). Dimension stone production has declined because more economical and stronger structural materials such as steel and reinforced concrete are now used. Other mass-produced substitute construction products

such as precast concrete panels, plastics, and metals are replacing the labor intensive dimension stone industry. However, recent technological advances in processing could stabilize production output.

Sand and gravel, and crushed stone industries may require more water for processing because of increasing demands for cleaner and better quality products. Sand and gravel, and crushed stone production fluctuate with construction activity, so their future water needs should parallel construction growth. Most production is currently in basins of greatest urban development--the Mississippi Headwaters, Kaskaskia-Meramec, Lower Illinois, and Upper Illinois.

Coal, iron ore, and zinc are not mined throughout the region like sand and gravel and stone. Central and southern Illinois are the major coal mining areas, but, as coal-fueled power plants expand, further mining is probable in south-central Iowa and northern Missouri. The coal industry will use more water to meet rising demands, to comply with cleaner coal requirements, and perhaps to transport coal. Coal transportation costs are substantial so an alternate transport system --coal slurry pipelines--has been proposed particularly for the western United States. If slurry pipelines were constructed in this region, large water quantities would be needed solely to transport coal.

Active iron ore and zinc mining are in only a few areas and no large changes in production are anticipated. Other mineral production, such as copper, nickel, and uranium mining in northern Minnesota, may be economically and technologically possible in the future and would significantly alter water use projections.

TABLE I-11. MINING WATER USE TO 2000, UPPER MISSISSIPPI REGION

	million gallons per day (MGD)		
	1974	1985	2000
Sand and Gravel			
Withdrawal	50	72	107
Consumption	1	1	2
Crushed Stone			
Withdrawal	8	12	19
Consumption	< 1	< 1	1
Dimension Stone			
Withdrawal	195	152	152
Consumption	2	2	2
Coal			
Withdrawal	14	23	39
Consumption	1	2	3
Iron Ore (taconite)			
Withdrawal	17	24	29
Consumption	8	11	13
Zinc			
Withdrawal	2	3	5
Consumption	< 1	< 1	< 1
Total Water Use			
Withdrawal	286	286	351
Consumption	12	15	21

Sources: U.S. Bureau of Mines, Mineral Industry of Illinois, 1974, Indiana, 1974, Iowa, 1974, Minnesota, 1974, Missouri, 1974, and Wisconsin, 1974.
U.S. Bureau of Mines, Mineral Trends and Forecasts, October 1976.
UMRCBS Coordinating Committee, Upper Mississippi River Basin Comprehensive Study, (Vol. III), 1970.

Irrigation

Approximately 687,200 acres in the Upper Mississippi Region were irrigated in 1977, of which 39 percent was in the Minnesota portion, 24 percent in Wisconsin, and 18 percent in Iowa (Table I-12). Sandy soils of central Minnesota are the most irrigated (Figure I-26). Groundwater yields from glacial drift and bedrock aquifers appear sufficient in this area for further expansion. Other areas of irrigation include the Central Sand Plain of Wisconsin; Mason County, Illinois; west central Iowa; and Audrain County, Missouri. Concentrated irrigation will continue to occur where soils are sandy, where agricultural productivity without irrigation is normally low, and where water is readily available.

The amount of water used in irrigation depends on the crop requirements and on the efficiency in transporting and applying water. Since most irrigation systems in the region have their own individual supply source, usually from groundwater, little water is lost in conveyance. Crop consumptive irrigation requirements are different with the larger needs in the western and southern areas. Water use for irrigation is about 5 percent of total annual withdrawal, but 30 percent of consumption. River basins in Minnesota and Iowa withdraw and consume more water than in other states (Figure I-27).

The exact rate that irrigation will expand has not been forecast. Irrigation

TABLE I-12. IRRIGATION WATER USE TO 2000, UPPER MISSISSIPPI REGION

	1977		1980		1985		1990		2000	
Irrigated Acres										
Upper Mississippi Region	687,200		990,000		1,390,400		1,749,000		2,448,900	
Illinois Portion	91,000		133,100		202,800		273,200		413,600	
Indiana Portion	15,700		17,200		19,600		22,000		26,900	
Iowa Portion	121,500		152,600		216,600		274,700		391,400	
Minnesota Portion	266,300		437,400		611,200		753,600		997,500	
Missouri Portion	29,500		54,300		86,000		114,500		196,900	
Wisconsin Portion	163,200		195,400		254,200		311,000		423,000	
	Dry Year[a]	Normal Year[b]	Dry	Normal	Dry	Normal	Dry	Normal	Dry	Normal
Withdrawal (MG)[c]	351,000	288,000	493,000	403,000	682,000	557,000	844,000	688,000	1,150,000	940,000
(MGD)[d]	2,280	1,870	3,230	2,640	4,440	3,630	5,510	4,480	7,470	6,090
Consumption (MG)	274,000	149,000	390,000	319,000	547,000	449,000	688,000	562,000	963,000	788,000
(MGD)	1,790	1,460	2,570	2,080	3,590	2,930	4,500	3,660	6,250	5,090
					High Efficiency					
Withdrawal (MG)	347,000	285,000	489,000	397,000	661,000	537,000	801,000	651,000	1,051,000	855,000
(MGD)	2,260	1,850	3,170	2,570	4,280	3,480	5,180	4,220	6,800	5,540
Consumption (MG)	273,000	223,000	388,000	316,000	533,000	429,000	659,000	536,000	893,000	727,000
(MGD)	1,770	1,440	2,510	2,050	3,460	2,780	4,270	3,470	5,780	4,700

[a]Precipitation rate which is equaled or exceeded 8 years in 10
[b]Precipitation rate which is equaled or exceeded 5 years in 10
[c]Million gallons per year
[d]Million gallons per day during growing season

Source: U.S. Department of Agriculture, Soil Conservation Service, Crop Consumptive Irrigation Requirements and Irrigation Efficiency Coefficients in the United States, June 1976.

acreage and water use could triple by 2000 which could create problems for states in allocating water and in preserving water quality. The significant factors that affect irrigation growth when adequate water resources are available include:

(1) the overall farm price-cost situation,
(2) the availability of appropriate financing to support irrigation development,
(3) the availability of energy and its relative cost,
(4) the type of legislation enacted for water, land, and energy use,
(5) short or long-term shortages of materials or equipment in the irrigation industry, and
(6) the support given irrigation development through research, educational programs, and market development.

Rising crop prices could increase irrigation growth because higher profits may make irrigation installation economical. Current irrigation costs are substantial. Initial investment estimates range from $50,000 to $95,000 to irrigate 150 acres with center pivot or traveling gun systems pumping at 600 to 900 gallons per minute from a well with less than 250 feet of lift. Annual costs per acre for sprinkler irrigation is approximately $90 to $250 depending upon well depth, pumping rate, irrigation system, and fuel type.[14]

Manufacture of irrigation equipment should increase as demand rises. Competition and technological advances could lower initial investment costs, thus further increasing irrigation growth. However, excessive demand could also create a material shortage.

Energy costs could be the major constraint for irrigation growth. Necessary allocations because of energy shortages could rank irrigation as a low priority user. Increases in energy prices and continued depression of commodity prices could possibly restrict use of irrigation and eliminate some irrigators.

Until recent years, state administration of water withdrawals has been nominal because of small depletions for domestic, industrial, energy, and navigation uses. But with the consumptive uses of irrigation, administrative procedures are being adopted to enforce "reasonable use" of water through permit systems or

[14]University of Minnesota, Agricultural Experiment Station, Water Sources and Irrigation Economics, Miscellaneous Report 150, 1978.

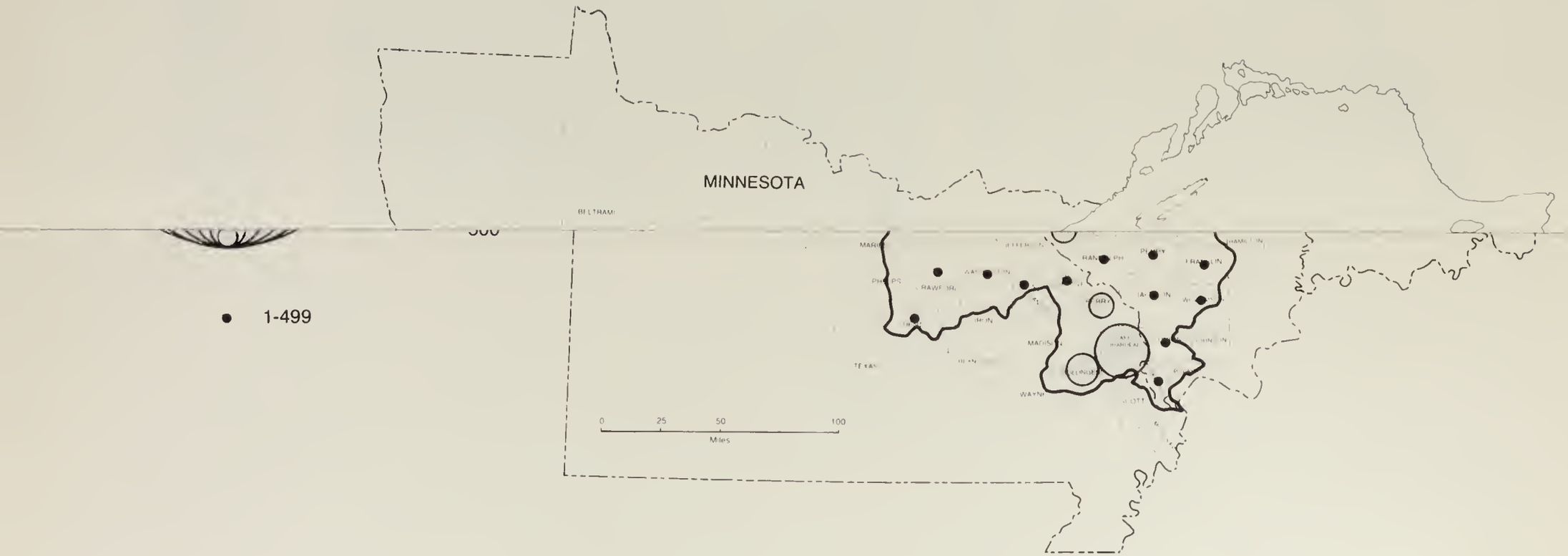


FIGURE I-26. IRRIGATED ACRES IN 1977 BY COUNTY, UPPER MISSISSIPPI REGION

Source: Compiled from irrigation surveys in Illinois, Indiana, Minnesota, Missouri, and Wisconsin and from water permit information in Iowa.

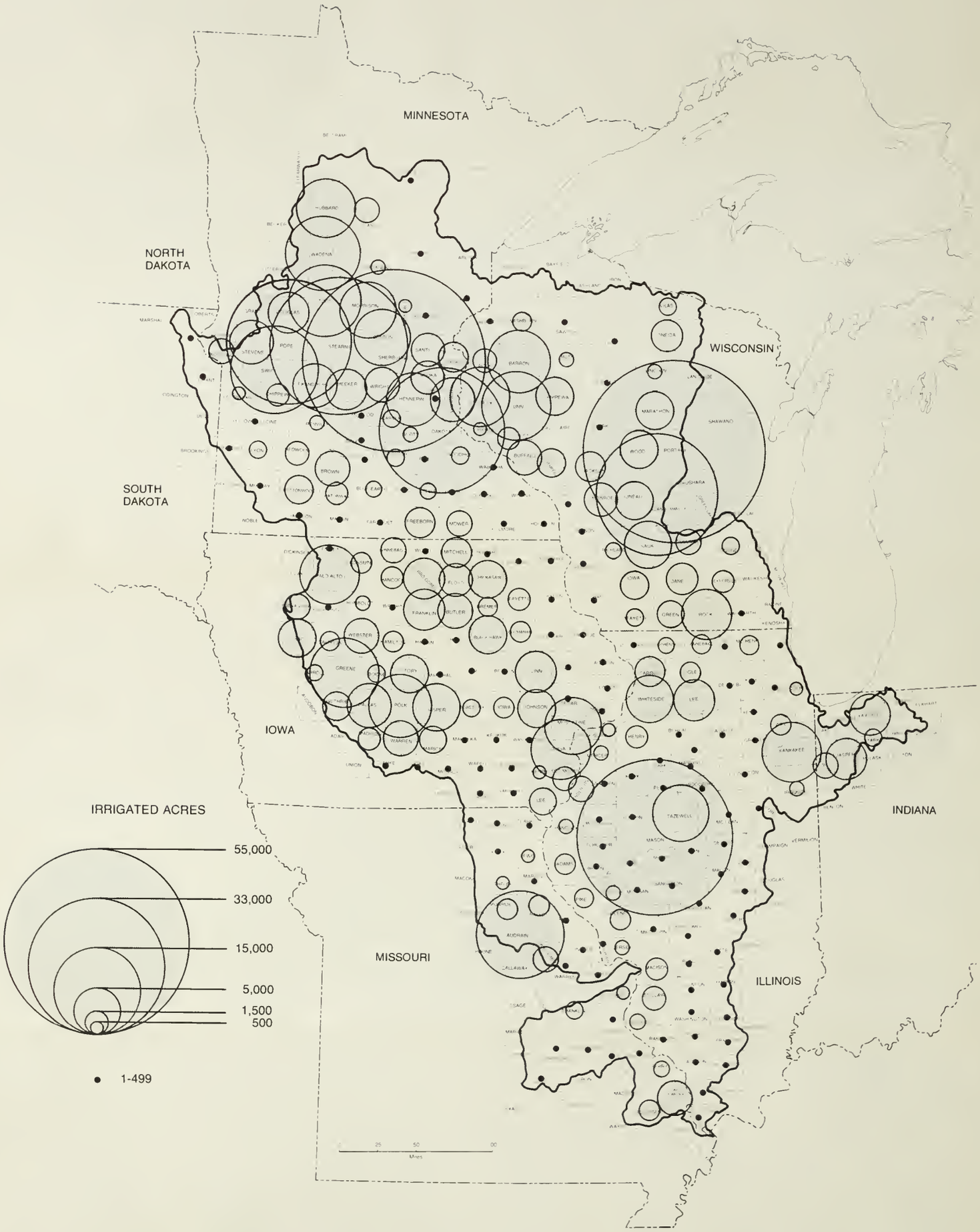


FIGURE I-26. IRRIGATED ACRES IN 1977 BY COUNTY, UPPER MISSISSIPPI REGION

Source: Compiled from irrigation surveys in Illinois, Indiana, Minnesota, Missouri, and Wisconsin and from water permit information in Iowa.

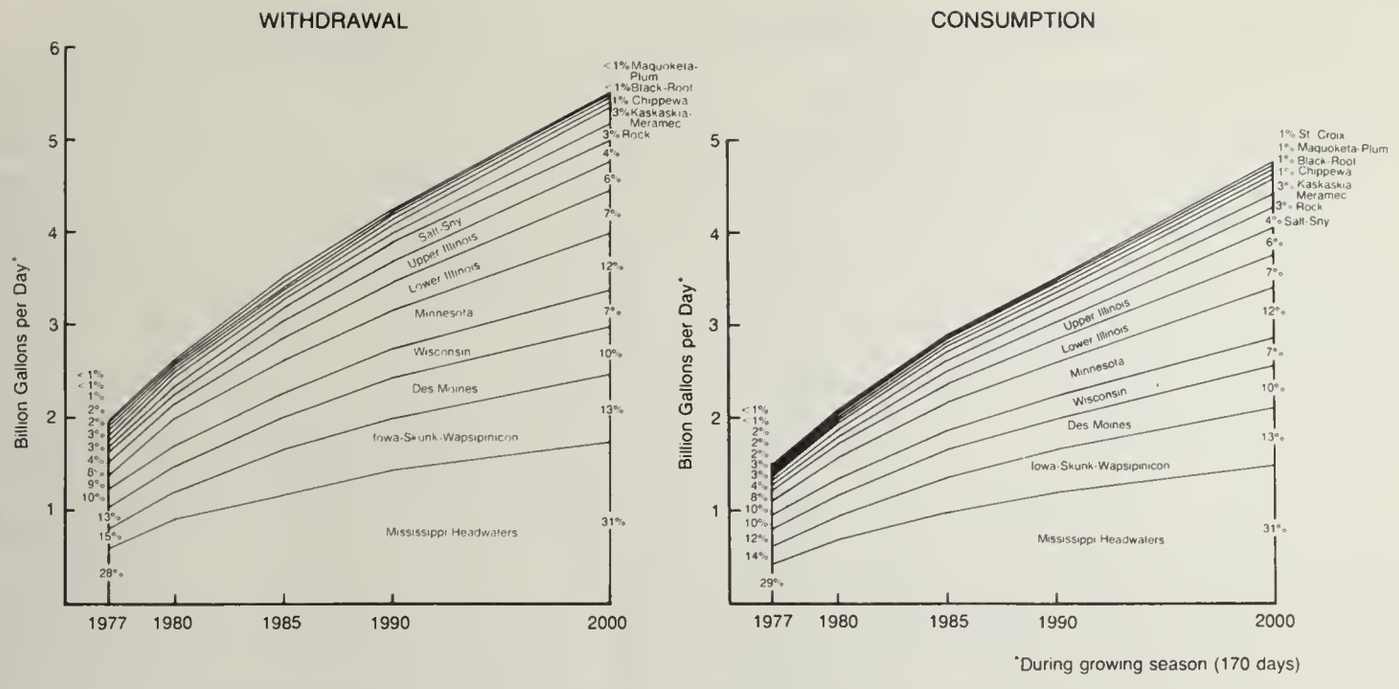


FIGURE I-27. IRRIGATION WATER USE TO 2000 BY SUBREGION*, UPPER MISSISSIPPI REGION

*Normal Precipitation and High System Efficiency

Source: U.S. Department of Agriculture, Soil Conservation Service, *Crop Consumptive Irrigation Requirements and Irrigation Efficiency Coefficients for the United States*, June 1976.

other means.[15] Government legislation can restrict excessive irrigation growth by limiting permits, water withdrawals, energy consumption, and loan funds. In addition, the support for advancing irrigation research and education can be essential in swaying public attitude towards irrigation.

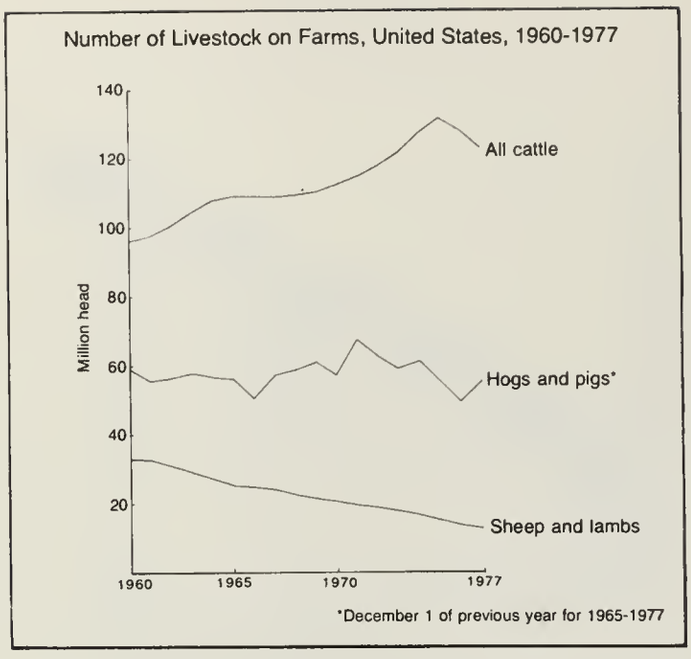
Livestock

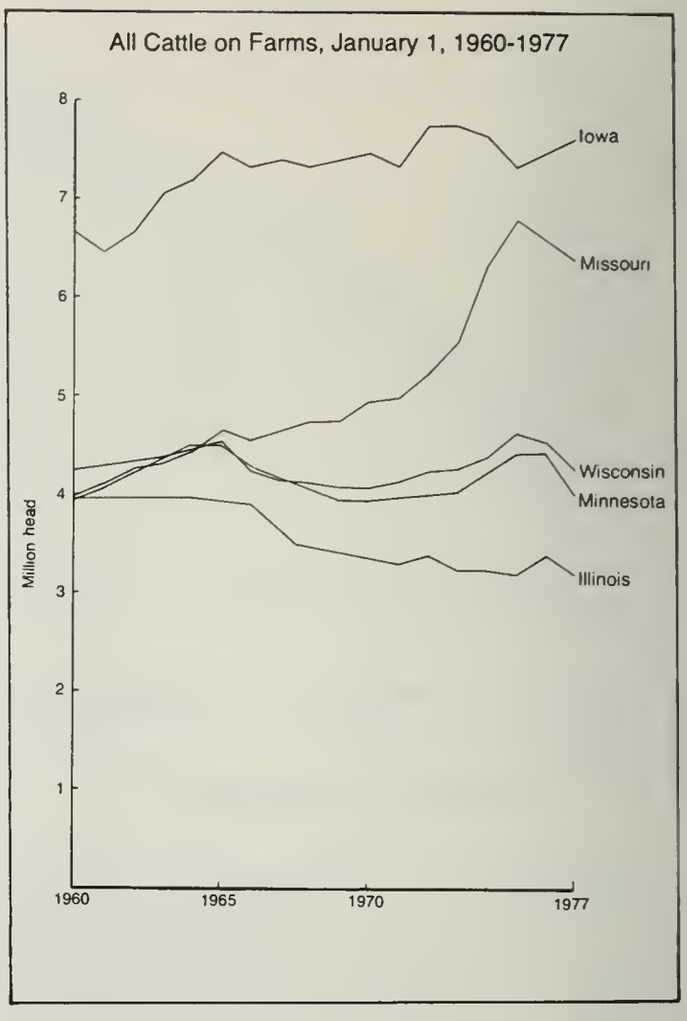
Livestock water use constitutes only a small percentage of total water withdrawal, although animal production is an important economic activity in the Upper Mississippi Region. Livestock numbers have varied only slightly in the United States since 1960 (Figure I-28). Cattle numbers have increased from approximately 96 million head in 1960 to a peak of 132 million head in 1975. Numbers of hogs and pigs have fluctuated around 56 million head. Sheep and lamb numbers have decreased steadily from 33 million head in 1960 to 13 million in 1977. Livestock numbers for states in the Upper Mississippi Region have generally followed national trends except for declining cattle numbers in Illinois.

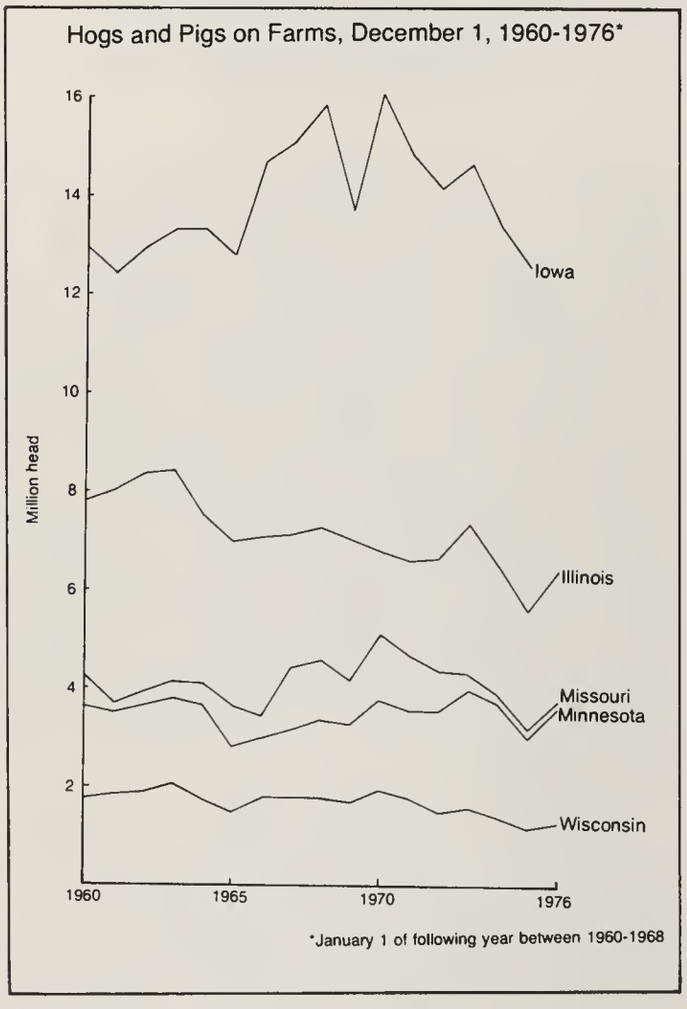
Dairy cow production is concentrated in Wisconsin, central and southeastern Minnesota, and northwestern Iowa. Beef and veal, and hog and pig inventories are largest in Iowa, northwestern Illinois, and southwestern Minnesota. Livestock water use is largest in the Iowa subregions and in the Black-Root and Minnesota river basins (Figure I-29). Current water use for livestock throughout the region is only 1 percent of all withdrawals but is 10 percent of total consumption.

Complex factors make long-term livestock forecasts difficult. Economic conditions, population growth, agricultural imports and exports, meat consumption habits, and livestock feeding and breeding practices can influence the national livestock numbers. Regional livestock numbers also are affected by climate, water availability, transportation, feedlot location, and land utilization conflicts. Two ranges of estimates for future livestock numbers are: (1) livestock numbers on farms

[15] U.S. Department of the Interior, U.S. Department of Agriculture, and Environmental Protection Agency, Irrigation Water Use and Management, June 1979.







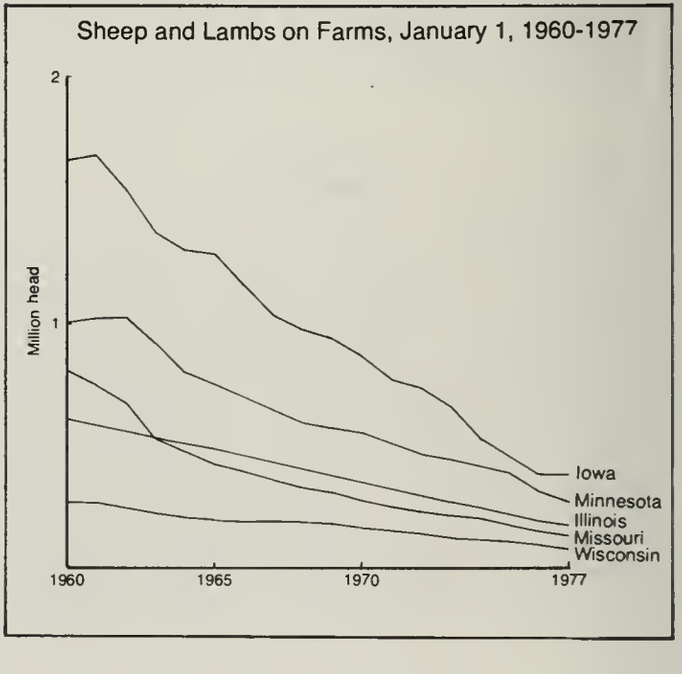


FIGURE I-28. LIVESTOCK ON FARMS, 1960-1977, STATES OF THE UPPER MISSISSIPPI REGION

Source: U.S. Department of Agriculture, Crop and Livestock Reporting Services, *Agricultural Statistics* for Illinois, Iowa, Minnesota, Missouri, Wisconsin, and the United States, 1976-1978.

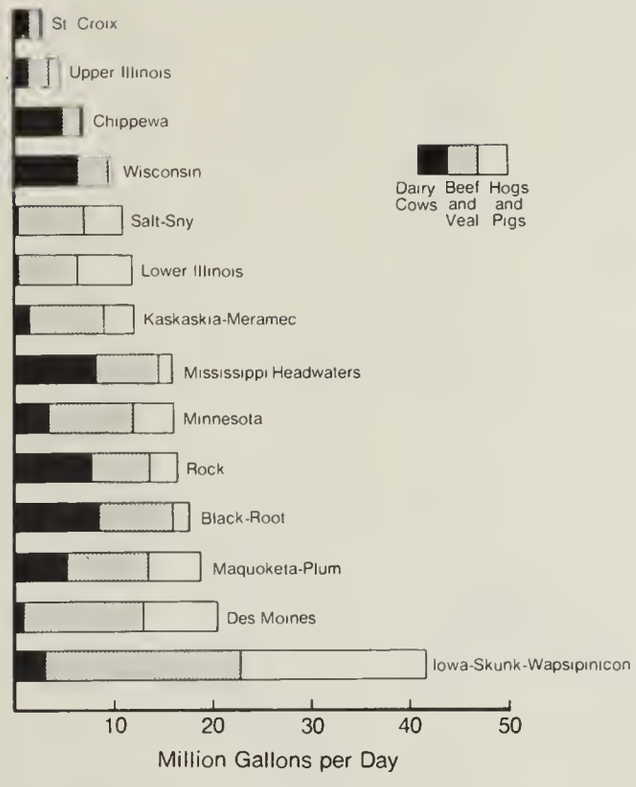


FIGURE I-29. LIVESTOCK WATER USE IN 1976 BY SUBREGION, UPPER MISSISSIPPI REGION

Sources: Illinois Cooperative Crop Reporting, *Illinois Agricultural Statistics 1977*, September 1977.
Indiana Crop and Livestock Reporting Service, *Indiana Crop and Livestock Statistics 1977*.
Iowa Crop and Livestock Reporting Service, *Iowa Agricultural Statistics 1977*.
Minnesota Crop and Livestock Reporting Service, *Minnesota Agricultural Statistics*, May 1977.
Missouri Department of Agriculture, *Missouri Farm Facts 1977*, April 1977.
South Dakota Crop and Livestock Reporting Service, *South Dakota Agriculture (Preliminary Statistics)*, 1977.
Wisconsin Statistical Reporting Service, *1977 Wisconsin Agricultural Statistics*, June 1977.
UMRBC-CCJP, Livestock Forecasts, July 1978.

remain constant, and (2) livestock numbers on farms increase at the national population growth rate (Table I-13). Livestock numbers would remain constant in spite of the projected population growth rate if meat consumption habits change and reduce meat demand, if advances in livestock management produce larger meat yields, or if meat imports rise. However, livestock numbers could increase at the population rate if current consumption and production patterns remain constant. Livestock production will likely have continued fluctuations because of changes in the production cycle.

Energy

Nuclear and coal-fired steam-electric plants generate most of the electricity in the region and are the largest water users because of their inherent cooling needs. Consequently these plants are located on the Mississippi River, its major tributaries, and large lakes that can meet the significant water flow needs of power plant cooling systems (Figure I-30). Hydroelectric facilities are concentrated in the northeast. Nuclear steam-electric plants are near large urban service areas.

Electrical generating plants in the region have a generating capacity of 37,953,000 megawatts (MW) and a generation of 127,875,000 gigawatt hours (GWh) annually. About 97 percent of the electricity is generated by steam-electric plants supplemented by hydroelectric, internal combustion and combustion turbine plants.

Water used for cooling purposes represents 57 percent of the region's average daily withdrawal but only 11 percent of consumption. Urban areas and associated development require a large energy supply generally resulting in high water use for power plant cooling purposes. Withdrawal and consumption are highest in Illinois, Minnesota, and along the Mississippi River (Figure I-31). These trends should continue to 2000.

Withdrawal and consumption rates of individual power plants vary according to the size of the energy facility and the type of cooling system employed. Nearly half of the electricity generated in the region is produced by steam-electric plants utilizing once-through cooling which is the most energy efficient and the least costly to install and maintain and consumes less water than other currently used cooling methods (Figure I-32). Waste heat is dispersed by water passing from a river or stream through a heat exchange and then back to the source. Water withdrawal is usually one cfs per megawatt for a fossil-fueled plant and one and one-half cfs for a nuclear power plant at 100 percent capacity factor. Waste heat from power plants was recognized as thermal pollution by the Clean Water Act of 1977 and closed-cycle recommended as "best available technology." All closed-cycle systems such as cooling ponds and wet towers recirculate cooling water and do

TABLE I-13. LIVESTOCK WATER USE TO 2020 (HIGH ESTIMATE)[a], UPPER MISSISSIPPI REGION

	WATER USE in million gallons per day (MGD)					
Upper Mississippi Region	1976	1980	1985	1990	2000	2020
Oairy Cows	48.0	56.3	59.2	62.2	66.5	75.3
Beef and Veal	96.8	100.4	105.3	110.5	118.7	133.7
Hogs and Pigs	55.7	58.3	60.9	63.9	68.6	77.1
Sheep	0.6	0.6	0.6	0.6	0.7	0.8
Illinois Portion						
Oairy Cows	4.4	4.5	4.8	5.1	5.6	6.3
Beef and Veal	17.6	18.2	19.2	20.3	21.7	24.4
Hogs and Pigs	14.2	15.0	15.5	16.3	17.7	19.7
Sheep	0.1	0.1	0.1	0.1	0.1	0.1
Indiana Portion						
Oairy Cows	0.2	0.2	0.2	0.2	0.2	0.2
Beef and Veal	0.6	0.6	0.6	0.7	0.7	0.8
Hogs and Pigs	0.4	0.4	0.4	0.4	0.5	0.5
Sheep	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Iowa Portion						
Oairy Cows	6.8	7.1	7.4	7.8	8.4	9.5
Beef and Veal	34.6	35.9	37.7	39.6	42.5	47.8
Hogs and Pigs	27.1	28.2	29.6	31.1	33.3	37.5
Sheep	0.2	0.2	0.2	0.2	0.3	0.3
Minnesota Portion						
Oairy Cows	15.4	16.2	17.1	17.9	19.1	21.6
Beef and Veal	20.7	21.6	22.7	23.6	25.5	28.7
Hogs and Pigs	8.1	8.5	8.9	9.3	9.9	11.1
Sheep	0.2	0.2	0.2	0.2	0.2	0.2
Missouri Portion						
Oairy Cows	0.8	0.8	0.8	0.9	0.9	1.1
Beef and Veal	9.5	9.9	10.4	10.8	11.7	13.2
Hogs and Pigs	3.2	3.3	3.5	3.7	3.9	4.4
Sheep	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
South Oakota Portion						
Oairy Cows	0.3	0.3	0.3	0.3	0.3	0.4
Beef and Veal	1.7	1.8	1.8	1.9	2.0	2.3
Hogs and Pigs	0.1	0.1	0.1	0.1	0.1	0.1
Sheep	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Wisconsin Portion						
Oairy Cows	26.1	27.2	28.6	30.0	32.0	36.2
Beef and Veal	12.2	12.5	13.0	13.7	14.7	16.6
Hogs and Pigs	2.6	2.8	2.8	2.9	3.2	3.7
Sheep	0.1	0.1	0.1	0.1	0.1	0.1

[a]Assumes that livestock numbers increases at the population rate of the United States.

Sources: Illinois Cooperative Crop Reporting Service, Illinois Agricultural Statistics 1977, September 1977.
Indiana Crop and Livestock Reporting Service, Indiana Crop and Livestock Statistics 1977.
Iowa Crop and Livestock Reporting Service, Iowa Agricultural Statistics 1977.
Minnesota Crop and Livestock Reporting Service, Minnesota Agricultural Statistics, May 1977.
Missouri Oepartment of Agriculture, Missouri Farm Facts 1977, April 1977.
South Oakota Crop and Livestock Reporting Service, South Oakota Agriculture (Preliminary Statistics), 1977.
Wisconsin Statistical Reporting Service, 1977 Wisconsin Agricultural Statistics, June 1977.
UMRBC-CCJP, Livestock Forecasts, July 1978.

not return the heated water directly to the original water source. Water withdrawal is less but cooling ponds and wet towers consume more water than once-through cooling--up to 50 percent more in wet towers.

Estimated withdrawal and consumption of cooling water in 1985 are 7380 MGD and 409 MGD. By 2000, withdrawal is estimated to decrease to 3523 MGD but consumption is estimated to increase to 1169 MGD.[16] Coal conversion and gasohol plants could result in even higher regional consumption rates if developed in Illinois and Iowa.

[16]These figures assume the implementation of the 1977 Clean Water Act resulting in higher consumption rates but lower withdrawals. Totals are estimated using percentage increase of large water-using plants. Federal Enegy Regulatory Commission, Electrical Generation Supply, 1975 data.

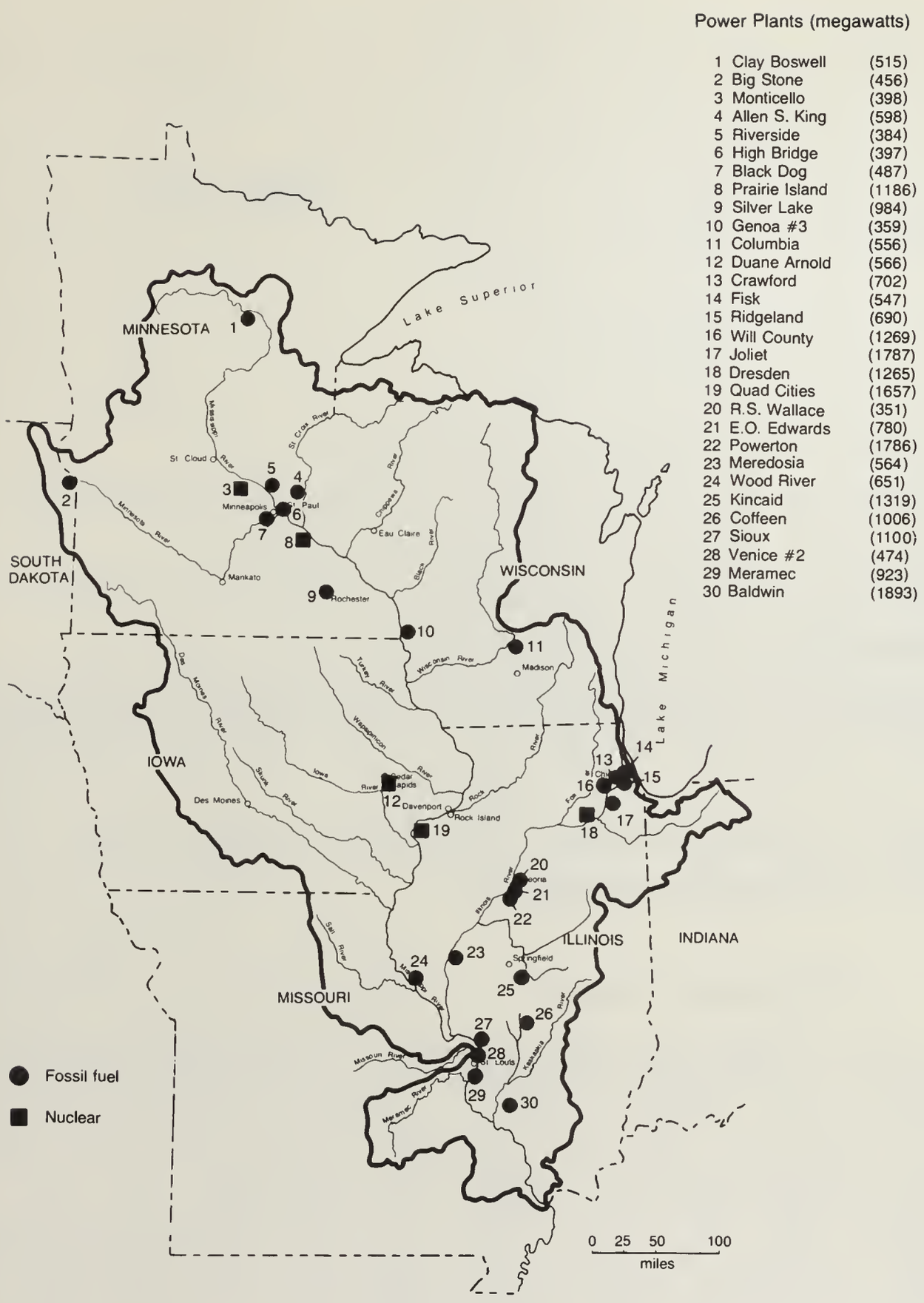


FIGURE I-30. MAJOR STEAM-ELECTRIC POWER PLANTS*, UPPER MISSISSIPPI REGION

*plants ≥ 350 megawatts only

Source: Federal Power Commission, *Existing Electric Generating Plants – 1975*, August 1977.

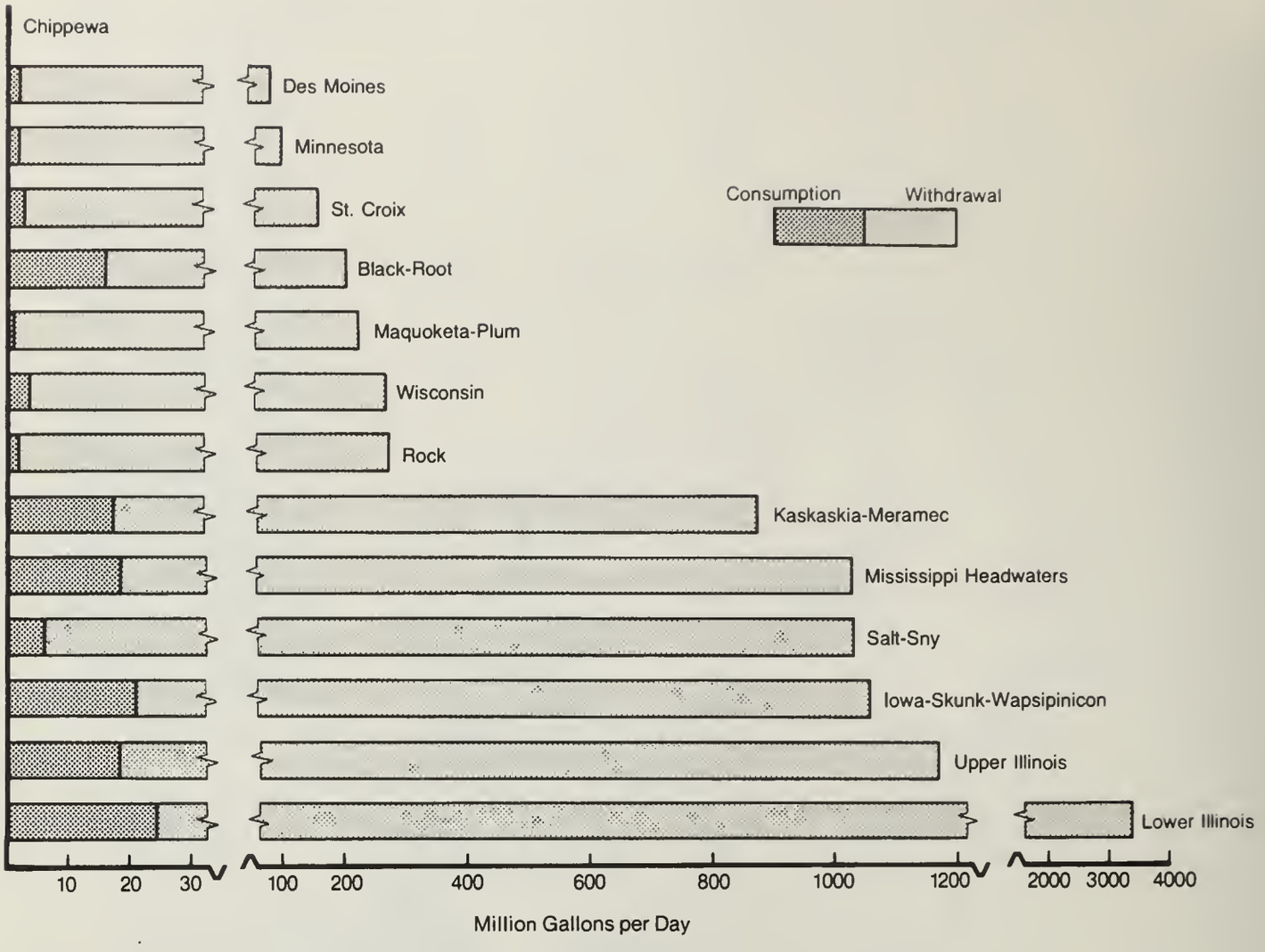


FIGURE I-31. POWER PLANT WATER USE BY SUBREGION, UPPER MISSISSIPPI REGION

Source: Federal Power Commission, *Principal Electric Facilities,* 1979.

Total Water Use: Summary

Water withdrawal in the Upper Mississippi Region has probably now peaked and may decline as industry complies with discharge limitations resulting from the Clean Water Act of 1977. Manufacturing and power plants should no longer be able to withdraw large quantities of water for cooling and processing and then return the non-consumed water to the original water source. Improvements in water use efficiency, particularly in energy and manufacturing when they shift toward closed-cycle cooling and greater water reuse, could offset future water demands. Energy will remain the largest withdrawal use and its water consumption rate should increase significantly (Table I-14). Consumptive water use in manufacturing could likewise have a similar but not as pronounced growth pattern. The most dramatic change in water use demands could be in irrigation where withdrawal and consumption may triple. Since irrigation is limited to the growing season and most other water uses peak in the summer, the daily average may exceed 2 BGD during peak seasonal use.

Chicago, St. Louis, and Minneapolis-St. Paul metropolitan areas and each's respective subregions are large water use areas (Figure I-33). These three subregions constitute over 57 percent of the total regional withdrawal and 47 percent of the consumption. Surface water supplies a major share of the water needs for the three metropolitan areas where Chicago uses Lake Michigan, and St. Louis and Minneapolis-St. Paul use the Mississippi River.

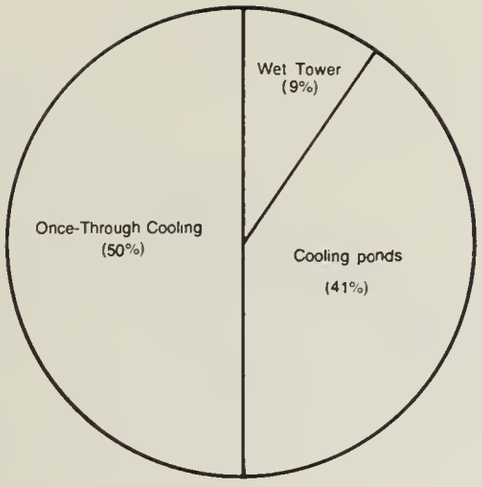


FIGURE I-32. ELECTRICAL GENERATION BY COOLING TYPE, UPPER MISSISSIPPI REGION

Source: Federal Power Commission, *Principal Electrical Facilities*, 1977.

The choice between surface water and groundwater use depends upon availability, quality, and need. Energy has the largest withdrawal need requiring a large supply source that is only available from surface water. Major rivers and reservoirs are necessary sites for power plants with large generating capacities. The location of future plants and the rate at which closed-cycle cooling systems are implemented will influence the pattern of energy water use. Surface water withdrawals for energy should decline for most rivers except the Rock River where additional plant construction may offset water use efficiency improvements.

Groundwater will remain the principal water source for irrigation. Water use permits will restrict the use of surface water for irrigation, and groundwater use may be confined to areas of high yields that are not threatened by excessive withdrawal or have a high contamination potential.

Domestic and manufacturing needs can be satisfied both through surface water and groundwater sources. In the north, groundwater yields are sufficient for most moderate local uses and development costs are not excessive. Since groundwater yields and quality are inferior in the south, surface water is often the preferred water source for municipal and industrial uses. However, in many cases individual homesteads and other small users can still use groundwater. Where surface water is the predominate water source, regional water systems will become more common. Economic costs for supply development and treatment can be often reduced through a large centralized supply and distribution system. Better water management and drinking water quality are also achieved with regional systems. As regional systems expand, further inter-basin water transfers may occur especially among the Salt-Sny, Upper Illinois, Lower Illinois, and Kaskaskia-Meramec river basins.

TABLE I-14. WATER WITHDRAWAL AND CONSUMPTION TO 2000 (BEST ESTIMATE)[a], UPPER MISSISSIPPI REGION

Average Annual Daily Water Use in million gallons per day

	1977		1980		1985		1990		2000	
	Withdrawal	Consumption	Withdrawal	Consumption	Withdrawal	Consumption	Withdrawal	Consumption	Withdrawal	Consumption
Domestic	2100 (13%)	638 (32%)	2173 (14%)	658 (27%)	2184 (7%)	693 (23%)	2182 (18%)	726 (20%)	2139 (22%)	781 (16%)
Manufacturing	3514 (22%)	379 (19%)	2738 (18%)	433 (18%)	1480 (11%)	515 (17%)	1357 (11%)	601 (16%)	1057 (11%)	775 (16%)
Mining	285 (2%)	12 (<1%)	282 (2%)	13 (<1%)	286 (2%)	15 (<1%)	305 (3%)	17 (<1%)	351 (4%)	21 (<1%)
Irrigation	775 (5%)	600 (30%)	1072 (7%)	847 (35%)	1452 (11%)	1171 (39%)	1759 (15%)	1444 (39%)	2318 (24%)	1971 (40%)
Livestock	210 (1%)	210 (10%)	216 (1%)	216 (9%)	226 (2%)	226 (8%)	237 (2%)	237 (6%)	246 (3%)	246 (5%)
Energy	9207 (57%)	176 (9%)	8521 (57%)	268 (11%)	7380 (57%)	409 (13%)	5997 (51%)	683 (18%)	3523 (37%)	1169 (23%)
	16,089	2015	15,002	2435	13,007	3029	11,837	3708	9634	4963

[a]Assumes an increase in water use efficiency for Domestic (OBERS "E" - Conservation) and Irrigation water uses. Manufacturing and Energy water uses continue to meet efficiency projections resulting from compliance with the 1977 Clean Water Act.

Source: Compiled from each water use component.

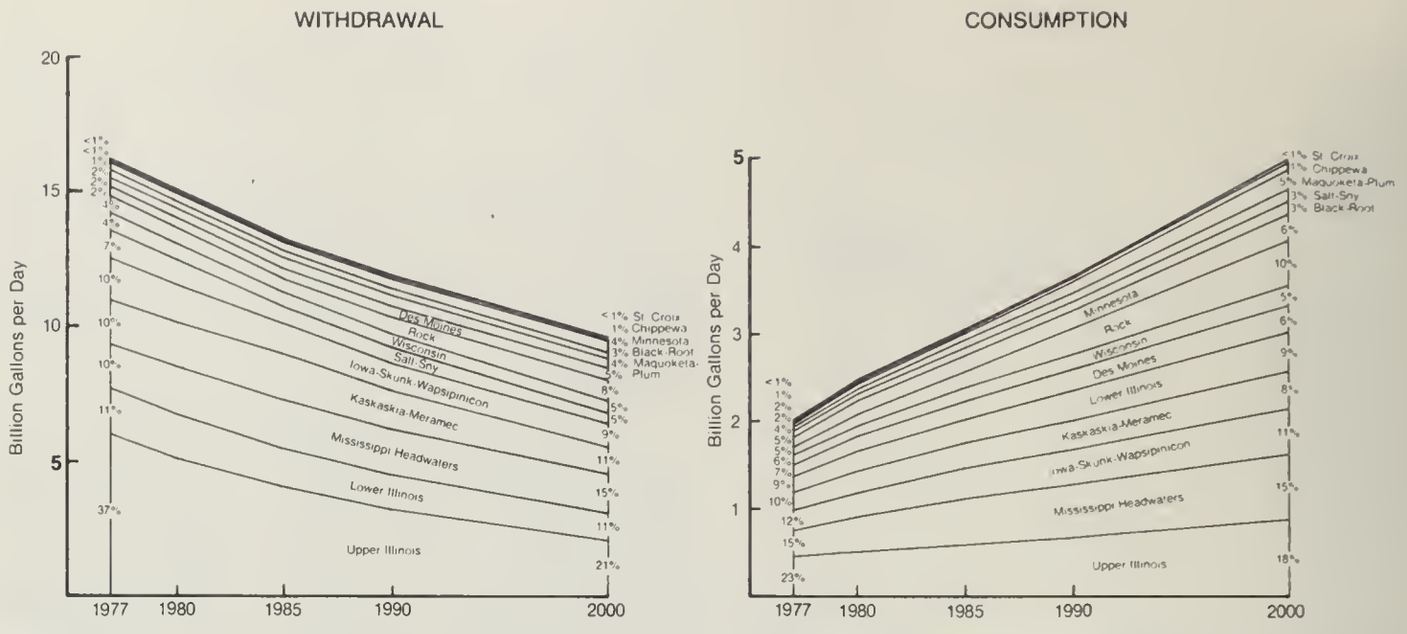


FIGURE I-33. AVERAGE ANNUAL DAILY WATER USE* BY SUBREGION, UPPER MISSISSIPPI REGION

*Assumes an increase in water use efficiency for Domestic (OBERS "E" — Conservation) and Irrigation water uses. Manufacturing and Energy water uses meet efficiency projections resulting from compliance with the 1977 Clean Water Act.

Source: Compiled from each water use component.

PART 2

PROBLEMS, NEEDS, AND ALTERNATIVE SOLUTIONS

INTRODUCTION

Part 2 is a regional analysis of problems, needs, and alternative solutions for the nine functional areas of water and related land resources: water supply, water quality, erosion and sedimentation, flood damage, water recreation, fish and wildlife, commercial navigation, energy, and instream flows. Contained in this part are descriptions of "current conditions and problems," "anticipated problems" "governmental authority, responsibility, and policy," "alternative solutions and effects," and "conclusion" for each of the functional areas.

Current problems, and anticipated problems and needs generally are determined from the population, economic, water use, and land use projections discussed in Part 1. Institutional arrangements and programs are identified and evaluated for their effectiveness in solving problems and meeting future needs. Alternative solutions to regional problems are evaluated utilizing the Water Resources Council's "Proposed Rules; Principles, Standards, and Procedures for Planning Water and Related Land Resources (P&S) (see Appendix D and E). The economic, environmental, regional, and social effects are assessed through a system of four accounts established by the P&S. Alternatives are developed that optimize either National Economic Development or Environmental Quality. The plan also identifies nonstructural alternatives. Before alternatives are recommended the relative efficiency and acceptability of each alternative are considered.

The scope and severity of problems and needs in the Upper Mississippi Region are determined from research in addition to state and local perspectives of subregion problems and needs. An informal survey of state agencies indicated that "erosion and sedimentation," "nonpoint source pollution," and "loss of fish and wildlife habitat" were perceived as the most severe problems in many of the subregions (Table II-1). Two problems, "groundwater contamination" and "urban water supply," were considered the least severe problems in most of the subregions. These results correlate with the results of a survey conducted by Louis Harris and Associates between October 19 and November 21, 1979. The Harris survey revealed that half of all U.S. adult citizens consider loss of good farmland and the misuse of soil and water resources to be "very serious" problems. Nearly 40 percent of those questioned by the Harris firm indicated that "water and soil are so important that continuing improvements in their quality must be made regardless of cost.[1]

In the Upper Mississippi Region, problems are varied and complex. Since water resources are abundant, only in limited geographic areas and under certain conditions do water supply problems occur. In the south, where surface water is the major supply source, low streamflows can seriously reduce water for municipal, industrial, and agricultural needs. Despite the general abundance of groundwater throughout much of the region, there are significant problems with declining groundwater levels and decreasing water quality. Water quality problems also vary within the region. Point source pollution problems generally

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[1]The USDA commissioned the Harris survey on behalf of the USDA and the RCA Coordinating Committee: U.S. Department of Agriculture, "Public Attitudes Revealed on Soil and Water Conservation," USDA News 151-80 (17 January 1980) and James Risser, "Survey finds Americans concerned about erosion," Des Moines Register 18 January 1980, p. 6.

In an Iowa public opinion study in 1979, soil erosion also was determined the greatest resource problem: "Says lawmakers ignoring public call for saving soil," Des Moines Register 12 April 1980, p. 13A.

In a survey of state government agencies engaged in environmental protection, natural resource management, and state planning the results indicated that water pollution and water resources management received the highest priority relative to the states' total program in environmental and natural resources: The Council of State Governments, State Information Needs for Resource Management by William Schneider, 1979.

TABLE II-1. SEVERITY OF PROBLEMS IN RIVER BASINS OF THE UPPER MISSISSIPPI BASIN

Relative severity in each River Basin: ● most severe ○ least severe[a]

Problem \ River Basin	Mississippi Headwaters	Minnesota	St. Croix	Black-Root	Chippewa	Maquoketa-Plum	Wisconsin	Iowa-Skunk-Wapsipinicon	Rock	Des Moines	Salt-Sny	Upper Illinois	Lower Illinois	Kaskaskia Meramec
Erosion and Sedimentation	●	●	●	●	●	●	●	●	●	●	●		●	●
Nonpoint Source Pollution	●	●		●	●	●	●	●	●	●	●	●	●	
Loss of Fish and Wildlife Habitat	○	●	●		●	●		●		●	●	●	○	●
Recreation Deficiencies	○	○	●		●		○		●			●		
Rural Flood Damages	●		○		○		●		○	○				●
Point Source Pollution		○		○	●		●							
Navigation/Water Use Conflicts		○		●								○		
Urban Flood Damages			○					○		○		●		●
Energy/Water Use Conflicts		○	●	●			○	○			○		○	○
Rural Water Supply	○	○	○	○		○	○				●		●	
Insufficient Instream Flows	○	●	○		○	○							○	○
Dam Hazards	●	○						○	○		○	○	○	
Urban Water Supply	○	○	○	○		○	○			○				●
Groundwater Contamination			○	●	○	○			○	○	○	○		○

[a] Most severe (above the upper quartile of the distribution of problem ratings)
Least severe (below the lower quartile of the distribution of problem ratings)

Source: This rating is from the aggregated results of subregion "Problem Rating Forms" completed in 1978 by each state with a portion of a subregion. These Forms were distributed during Phase 2 of the Preparation of the Water Resources Management Plan (see Appendix B) to obtain information on water resources and related problems. The rating of these problems is a perception of each problem's relative severity in a subregion and is used to compare with data and research that substantiate the uiscussion in Part II.

are not severe and will continue to improve as wastewater treatment facilities are completed in accordance with the law. Nonpoint source pollution, however, will remain pervasive without expanded funding for implementation of controlling measures. As a result of excessive phosphorus and nitrogen run-off levels, eutrophication is accelerated. The most serious threat to groundwater resources is an accident from hazardous waste disposal.

Soil erosion and sedimentation are the most severe water and related land resource problems. Unacceptable levels of erosion are occurring on 32 percent of the 67 million cropland acres. Funding levels for soil erosion programs are inadequate and without priority attention, severely depleted soils will affect the

region in the next 50 to 100 years.

Flooding is also a pervasive problem in the region and damages are rising annually. Agricultural flooding causes the greatest financial losses, but urban flooding is a greater problem since more lives are threatened, communities are disrupted, and property is damaged. Continued encroachment onto floodplain areas will exacerbate these flooding problems unless more stringent regulations restricting floodplain development are adopted throughout the region.

Recreation problems are not severe and can be solved through increased sensitivity to conservation and by planning for more efficient facility use rather than construction and development. Many problems will abate when erosion, sedimentation, and water pollution are mitigated. Fish and wildlife resources are as susceptible to development as recreation but are more fragile and less easily repaired or replaced. Along the Mississippi River, fish and wildlife resources are threatened by navigation-related activities. Although fish and wildlife habitat is being seriously degraded, conservationists select wetland preservation as the most urgent of all the fish and wildlife problems confronting the public. Wetland preservation has increased significantly largely because of its value to fish and wildlife and as a measure to reduce flooding and water pollution.

Objectives for managing the economic and environmental resources of the Upper Mississippi River System are not always compatible. Activities to maintain the navigation channel and proposed activities to expand navigation capacity have adversely affected fish and wildlife habitat and water quality. The rising demand for navigation has caused lengthy delays at locks and dams and serious river traffic congestion.

Steam-electric power generation contributes most of the energy for the region and is also the largest water user. Renewable energy sources and conservation may not be increasing fast enough to significantly reduce projected demand for energy facilities. Expanded use of closed-cycle cooling facilities for steam-electric power plants will significantly increase water consumption and may accentuate water supply and instream flow problems in areas of concentrated energy development.

Instream flow needs is a growing concern because of the rising demands from water users. Offstream water use has only minimal effects on the flows of most streams in the region. Nevertheless, municipal, industrial, and agricultural water demands can almost deplete flows in smaller streams during seasonal low flows. These problems are most apparent in the western and southern portions.

WATER SUPPLY

Current Conditions and Problems

The Upper Mississippi Region has surplus water resources, but availability and needs vary throughout because of climate, landforms, earth materials, and land uses. In the north, surface water supplies are large, but groundwater is usually used to meet the limited demands of the area. Surface water becomes the major supply source only where a surface supply is readily accessible to a large water user, or where groundwater quantity or quality necessitates construction of surface impoundments. The Mississippi, Minnesota, Black, Iowa, Skunk, Des Moines, Fabius, Salt, Kankakee, Vermilion, Illinois, Sangamon, Missouri, Meramec, Kaskaskia, and Big Muddy rivers are the principal rivers used for municipal and industrial supply. The principal lakes and reservoirs used as sources of water supply are Michigan, Springfield, Bloomington, Rend, Carlyle, Shelbyville, Carlinville, Jacksonville, and Decatur. Numerous impoundments, particularly in the south, supply water for small communities. Collectively, the total supply from impoundments is nominal as compared to the supply from streams and lakes.

Groundwater is the primary source of water for most municipalities, rural communities, and farms. Small water demands can be usually satisfied by drilling wells into unconsolidated or bedrock aquifers. Only a few locations have groundwater yields that may be too low for small water needs (Figure II-1). Areas in Minnesota and Wisconsin where pre-Cambrian rocks are near the land surface have minimal water yields, but wells can still support the generally small local needs. Thin sandstone and limestone formations of the Pennsylvanian age yield small quantities of water in areas of Illinois and Iowa, but again, many farms and small communities rely entirely on these sources for water. Despite the general abundance of groundwater, significant local problems such as declining groundwater levels, decreasing water quality, inadequate groundwater information, and competition for available water must be considered.

Long-term water table decline is uncommon in the region, although some areas have had serious declines from excessive groundwater pumpage. Loss of wetlands and stream channelization can also have some effect on groundwater recharge. In general, the water table under natural conditions declines in summer and early fall and rises in the wet spring months.

Water levels are lowest during extended dry periods. Municipal wells that pump from shallow sand and gravel aquifers are particularly susceptible to critical low levels during droughts because yields of sand and gravel aquifers often exceed natural recharge. Many municipalities will only experience supply problems when dry conditions persist. Some municipalities that use sand and gravel aquifers can create critical water level declines even during normal precipitation years because of extremely heavy concentrated pumpage. In Peoria, Illinois water levels were critically low in the 1940s, but levels recovered as pumpage was reduced and artificial recharge implemented.

Severe water-level declines in bedrock aquifers may occur in areas of heavy pumpage, especially if recharge is reduced from prolonged dry conditions and destruction of prime recharge sites. Densely populated areas which rely on bedrock aquifers for a large share of their water needs have the greatest potential for water-level declines. Water-level declines in the Cambrian-Ordovician aquifer in the Chicago area are the best example in the region. Since the 1860s water-level declines of more than 750 feet have been estimated in the aquifer.[2]

The Chicago, St. Louis, and Minneapolis-St. Paul areas have the largest water demands in the Upper Mississippi Region, but water resources are adequate for current demands. The water sources for Chicago are Lake Michigan, shallow aquifers (sand and gravel, and shallow dolomite), and deep aquifers (Cambrian-Ordovician and Mount Simon).

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[2]Robert T. Sasman and Richard J. Schicht, "To Mine or Not to Mine Groundwater," Journal of American Water Works Association 39 (March 1978): pp. 156-161.

FIGURE II-1. LOW-YIELD SOURCES OF GROUNDWATER, UPPER MISSISSIPPI REGION

Source: U.S. Geological Survey, *Summary Appraisals of the Nation's Ground-Water Resources – Upper Mississippi Region,* Professional Paper 813-B, 1975.

The use of shallow aquifers, however, will be abandoned and Lake Michigan water will be used to recharge aquifers. Other management efforts are essential to assure an ample future supply because Lake Michigan use is limited and total sustained yields of the aquifers are now being surpassed.

Water supplies in the St. Louis area are available from rivers and from alluvial and bedrock aquifers. The Mississippi, Missouri, and Meramec rivers account for almost the entire pumpage. Bedrock and alluvial aquifers can provide a larger share of the water supply, but additional surface water development is necessary to meet future demands during droughts.

The Minneapolis-St. Paul area also relies on surface water which poses problems at severe low flows. Minneapolis pumps directly from the Mississippi River while St. Paul pumps Mississippi river water into a chain of reservoir lakes. Most suburban areas use the abundant groundwater resources available for their supplies. Minneapolis is developing water supplies from groundwater to eliminate total dependence on a single resource, to increase its reserve supply beyond one day, and to reduce demand on the Mississippi River during severe droughts. Water-level seasonal declines will become more excessive with additional groundwater pumpage for the central cities, surrounding suburbs, and nearby irrigated cropland in Dakota County.

Agriculture uses groundwater for many production activities. Irrigation has become increasingly popular in the 1970s and has altered previous forecasts for agricultural water needs in the region. Current prime irrigation areas in central Minnesota, west-central Iowa, Lee and Mason counties, Illinois, and Audrain County, Missouri, use groundwater almost exclusively. Areas in central Wisconsin use some surface water for irrigation, but most irrigation is still with groundwater.

Irrigation growth has prompted studies on aquifer water availability and quality. Much irrigation water is pumped from surficial sand and gravel aquifers that must be capable of supplying both seasonal and short-term peak use demands. The quality of the irrigation water is generally determined from its total salts content; the higher the salts content the poorer the quality. Site studies by technical staff of the local soil and water conservation district can help determine the groundwater potential for irrigation in a particular area. Without an adequate reconnaissance of groundwater resources, excessive pumpage can create local supply problems for other uses.

The return flow of water into the aquifer after irrigation may create water quality problems because the water contains chemicals associated with farming activities. Contamination of groundwater resources may extend to deeper bedrock aquifers particularly in Karst areas. Fortunately, these Karst areas in southeastern Minnesota, northeastern Iowa, and east-central Missouri have minimal irrigation development.

Livestock water use is small in comparison to irrigation, but there is a more widespread need throughout the region for ample supplies than for irrigation. In southern Iowa, northeastern Missouri, and southwestern Illinois, small farm ponds, which may dry-up during droughts, provide a large share of the water for livestock. Feedlots generally have sufficient available water sources for livestock in dry periods but their concentrations of animals can be a potential water contamination source.

The largest non-consumptive water need in the Upper Mississippi Region is for energy production. Surface water supplies almost the entire energy need because of the large volumes of water required for cooling systems. The Mississippi and Illinois rivers have flows sufficient to support the largest number of major power plants. As power plant cooling systems become more water consumptive in compliance with existing legislation, flows of some streams could be severely affected during seasonal low flows. Water quality, instream flows, fish and wildlife habitat, and offstream water uses may be adversely influenced by this additional consumptive diversion.

The distribution and quality of available water resources during normal and dry periods and the exploitation of these resources by municipalities, industry, agriculture, and energy determine current and potential supply problems in the region. Most municipal problems are evident only during droughts. In the northern half of the region, additional wells or drilling deeper wells into bedrock aquifers can

often improve the available water supply for municipalities. In much of the southern and western portions, groundwater may not be available or is of such poor quality in both shallow and deep aquifers that it is impractical to attempt further groundwater development. Regional water systems that distribute water from major surface reservoirs, rivers, or alluvial aquifers are frequently developed to assure water supply for deficit areas. Although water resources are available, the investment and expenditure of developing wells or distribution systems may exceed the financial capabilities of an area. In addition, the Safe Drinking Water Act proposed new water quality standards that could require larger capital and operating costs to improve water treatment. Although many small water supply problems are scattered throughout the region, three major areas can be delineated (Figure II-2). In northeastern Missouri, western Illinois, and southern Iowa, groundwater yields are low and highly mineralized. Unlike other areas in central and southern Illinois, which also have inferior groundwater conditions, this area has not yet developed extensive regional water systems. Some systems have been constructed, such as the Clayton-Camp Point System in Illinois which transfers water from a sand and gravel aquifer near the Mississippi River to municipalities in Adams, Hancock, and Schuyler counties, but further development is necessary to assure urban and rural supplies.

In northeastern Illinois, large concentrated water withdrawals from aquifers have reduced water levels. Shallow aquifers in some locations have demands in excess of water amounts available from natural recharge and deep Cambrian-Ordovician aquifers have withdrawals approximately two and one-half times the rate of natural recharge. This water depletion will create deficits for many municipalities that rely on groundwater. The problem is further compounded because Wisconsin also uses the deep aquifer and most recharge sites are in Wisconsin. A joint state effort to promote a program of efficient water use, protection of existing recharge areas, artificial recharge, and possible water importation necessary to avert a water supply shortage and interstate conflicts.

Karst areas in southeastern Minnesota, northeastern Iowa, and southwestern Wisconsin have a severe groundwater contamination potential because limestone allows little natural filtration or purification for water entering the aquifers. Bacteria and nitrate levels in wells of some municipalities have exceeded standards. The abundant groundwater resources of this area are mainly threatened by runoff from cultivated land and feedlots, and by poorly located waste disposal sites and sewage treatment systems. Abandoned and improperly constructed wells also offer a contamination pathway that is a severe problem in this area as well as for other areas in the Upper Mississippi Region.

In summary, current water supply conditions are generally excellent throughout the region. Few water-deficit areas exist and the quality of the drinking water is usually adequate with only minor expenditures for treatment systems. Nevertheless, better management of water resources is necessary because: (1) severe shortages will occur in some locations during droughts with larger water demands and greater competition for quality water, (2) excessive groundwater use will create water-level declines and perhaps cause regional conflicts, (3) greater reliance on regional water systems requires sufficient resource data to assure proper use and adequate supplies, and (4) contamination of both surface water and groundwater resources is becoming increasingly evident and requires water quality, erosion, and land use programs.

Anticipated Problems

The water quality of surface water and groundwater resources will remain the fundamental water supply concern throughout the region. Both point and nonpoint pollution sources increasingly threaten the water supply for domestic, agricultural, and food processing uses. Hazardous chemicals that previously were unable to be monitored are now evident in many water supplies. More stringent drinking water standards may make it necessary for some suppliers to add treatment processes that reduce the concentrations of hazardous chemicals or to find an alternative supply source. Regional water supply systems will probably expand to serve areas where water

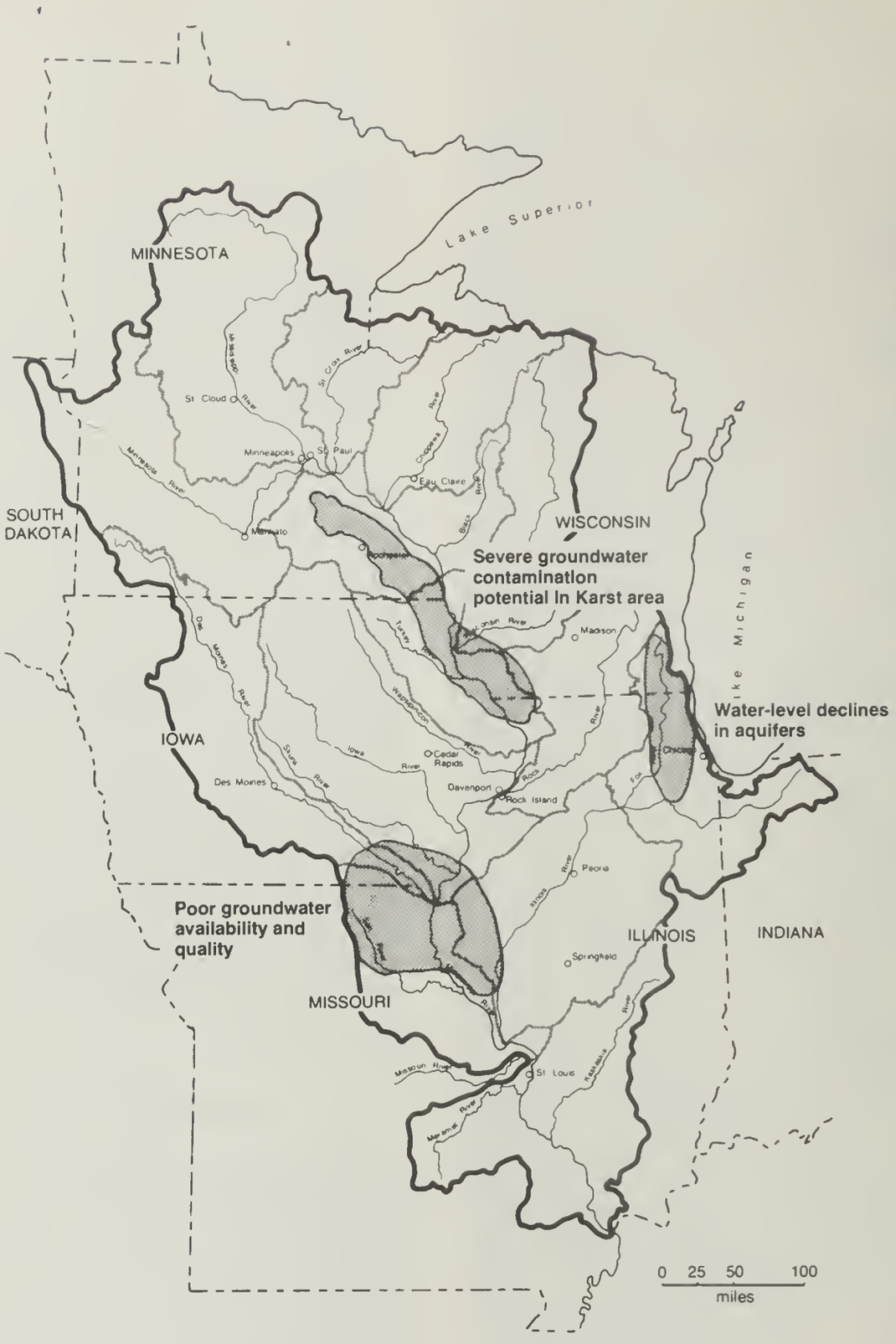

FIGURE II-2. MAJOR WATER SUPPLY PROBLEM AREAS, UPPER MISSISSIPPI REGION

Sources: Determined from Problem Ratings and delineated from Subregion Plans.

supplies are so severely polluted that treatment costs would be prohibitive.

Water withdrawal in the Upper Mississippi Region has possibly peaked at 16 BGD and should decline as efficiency improves from greater water reuse. Energy and manufacturing water use methods will differ from past technologies which withdrew large water quantities with little water consumption and recirculation. A delay in implementing water recirculation systems would alter current water use projections. Nevertheless, water resources are sufficient in most locations to meet the larger water withdrawal requirements that would accompany a lower water use efficiency. Less water consumption could also have beneficial effects on the flows of some streams.

Irrigation will have the greatest withdrawal rate increase of any user and will be primarily concentrated in areas where sand and gravel aquifer yields are large. Heavy localized pumpage could cause water-level declines which may affect other rural water needs. Perhaps a potential problem of greater concern is the contamination of sand and gravel aquifers by the return infiltration of irrigation water. Most unconsolidated aquifers have a high susceptibility to contamination.

Water availability problems will generally only become noticeable in the region during droughts or in areas of excessive groundwater pumpage. Many suppliers lack an adequate drought disaster contingency plan and are unable to implement suitable conservation safeguards. Until the suppliers that are most susceptible to dry periods establish an educational and mandatory conservation program, problems will arise whenever droughts occur.

Groundwater will continue to satisfy the needs of most of the Upper Mississippi Region, but in some locations excessive use, limited yields, or inferior quality will create problems. Uncoordinated groundwater management programs could compound problems and start interstate conflicts over the use of major deep aquifers, if one state allow intensive use and another restricts use. Interstate coordination is essential to safeguard the water rights of each state. Intensive studies of groundwater supplies from aquifers in the subregion are necessary to monitor water levels and to assist any water allocation program. A water use priority system should be implemented preferably on an aquifer basis when supply sources are limited.

Governmental Authority, Responsibility, and Policy

In the Upper Mississippi Region, cities and industries have been primarily responsible for developing water supplies for domestic, municipal, and industrial purposes. Abundant water resources that generally make it possible for local interests to develop supplies at reasonable costs have delayed the need for state water use regulations. No direct federal funding of water supply development projects has occurred except for some assistance through deferred payments in the groundwater-deficient southern and western sections where water supply is sometimes integrated into multi-purpose projects. Cost-sharing for water supply development projects requires total repayment of federal costs within 50 years after the water supply storage is first used, or within the life of the project.[3] These costs prohibit development of federal water supply projects because more economical supplies are usually available. Federal programs have been created under which grants and loans are made available to cities for meeting their expanding water supply needs (Table II-2).

Federal programs that are limited to economically depressed areas provide the greatest amount of assistance to cities for water supply projects. Most funding assistance is through repayable loans and grants for communities. The Farmers Home Administration is the major source of national water supply funding and most is through the Water and Waste Water Disposal System for Rural Communities Program. However, the largest potential source of grant aid has been the Community Development Block Grant Program of the Department of Housing and Urban

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[3]Water Supply Act of 1958 (P.L. 85-500) as amended by the Federal Water Pollution Control Act Amendments of 1961 (P.L. 87-88).

TABLE II-2. GOVERNMENTAL AUTHORITY AND RESPONSIBILITY FOR WATER SUPPLY UPPER MISSISSIPPI REGION

Agency		Authority[a]	Primary Program (function)
		U.S. GOVERNMENT	
DEPARTMENT OF AGRICULTURE			
Farmers Home Administration	I	Consolidated Farms and Rural Development Act (P.L. 92-419)	Water and Waste Disposal Systems for Rural Communities (grants and loans)
	I	Consolidated Farms and Rural Development Act (P.L. 92-419)	Soil and Water Loans (domestic, livestock, and irrigation water systems)
	I	Consolidated Farms and Rural Development Act (P.L. 92-419)	Irrigation, Drainage, and Other Soil and Water Conservation Loans
Soil Conservation Service	I	Watershed Protection and Flood Prevention Act (P.L. 83-566)	Watershed Protection and Flood Prevention (supply storage in small reservoir projects)
DEPARTMENT OF THE ARMY			
Corps of Engineers	I	Water Supply Act of 1958 (P.L. 85-500)	(allocation of water supply in multi-purpose projects)
	S	Water Resources Development Act of 1974, Section 22 (P.L. 93-251)	Planning Assistance to States
DEPARTMENT OF COMMERCE			
Economic Development Administration	I	Public Works and Economic Development Act of 1965 (P.L. 89-136)	Economic Development--Grants and Loans for Public Works and Development Facilities
DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT	I	Housing and Community Development Act of 1977 (P.L. 95-128)	Community Development Block Grants (improve urban water supply systems)
	I	Disaster Relief of 1974 (P.L. 93-288)	Disaster Assistance (funds for public works repair)
DEPARTMENT OF THE INTERIOR			
Bureau of Indian Affairs	E,I	-----	(regulates and enforces water rights for diversions in Indian Reservations)
Office of Water Research and Technology	S	Water Resources Research Act of 1964 (P.L. 88-379)	(grants for state water research institutes)
U.S. Geological Survey	S	Act of March 3, 1879	Water Resources Investigations (groundwater data acquisition and stream gaging)
ENVIRONMENTAL PROTECTION AGENCY	E,I	Safe Drinking Water Act (as amended by P.L. 95-190)	Drinking Water Supply--Standards Setting and Technical Assistance
	E,I	Safe Drinking Water Act (as amended by P.L. 95-190)	State Public Water System Supervision Program Grant
	E,I	Safe Drinking Water Act (as amended by P.L. 95-190)	Safe Drinking Water Research and Demonstration Grants
	E,I	Safe Drinking Water Act (as amended by P.L. 95-190)	State Underground Injection Control Program Grants
	E,I	Safe Drinking Water Act (as amended by P.L. 95-190)	Sole Source Aquifer Program
	R	Clean Water Act (P.L. 95-217)	(compliance with effluent discharge limit induce less water withdrawal)
		ILLINOIS	
DEPARTMENT OF COMMERCE AND COMMUNITY AFFAIRS	S	IL Statutes, Chapter 127	(lead agency for water conservation)
DEPARTMENT OF TRANSPORTATION			
Division of Water Resources	I	IL Statutes, Chapter 19 and 127	State Water Supply Development Program
	S	IL Statutes, Chapter 19 and 127	(cooperator for water development projects, stream gaging, hydrologic studies)
ENVIRONMENTAL PROTECTION AGENCY			
Division of Public Water Supply	E,I	IL Statutes, Chapter 19	(administers Safe Drinking Water Act)
INSTITUTE OF NATURAL RESOURCES	S	IL Statutes, Chapter 127	
Geological Survey Division			(geological and mineral research)
Water Survey Division			(primary water research agency)
WATER RESOURCES COMMISSION	S	IL Statutes, Chapter 19	(proposes grants for local government units for water resources projects)
		INDIANA	
DEPARTMENT OF NATURAL RESOURCES			
Division of Water	S,R, E,I	IND Statutes	State Water Supply Development Program
			(cooperator for water development projects, stream gaging, hydrologic studies)
			(administers state water use permit system)
STATE HEALTH BOARD	E,I	IND Statutes	(administers Safe Drinking Water Act)

TABLE II-2. (Continued)

Agency	Authority[a]		Primary Program (function)
		IOWA	
DEPARTMENT OF ENVIRONMENTAL QUALITY Water Quality Commission	E,I	1A Statutes, Chapter 455B	(administers Safe Drinking Water Act)
IOWA GEOLOGICAL SURVEY	S	1A Statutes, Chapter 305	State Water Resources Data System Program (cooperator for stream gaging and hydrologic studies)
NATURAL RESOURCES COUNCIL	S,R,E	1A Statutes, Chapter 455A	(administers state water use permit system) (prepares Comprehensive State Water Plan)
		MINNESOTA	
DEPARTMENT OF HEALTH	E,I	MN Statutes, Chapter 115, 144, 156A	(administers Safe Drinking Water Act)
DEPARTMENT OF NATURAL RESOURCES	S	MN Statutes, Chapter 105.391	State Public Water Inventory Program
	R,E	MN Statutes, Chapter 105.44	Water Appropriation and Permit Program
	S	MN Statutes, Chapter 105	State Water Conservation Program
	S	MN Statutes, Chapter 105	Water Quality Research and Support Program
DEPARTMENT OF PUBLIC SAFETY	S,I	MN Statutes, Chapter 12	Drought Contingency Planning Program
		MISSOURI	
DEPARTMENT OF CONSUMER AFFAIRS, REGULATIONS AND LICENSING	E,I	Senate Bill No. 1, Section 4 (1974)	(administers federal assistance programs) (licenses water supply systems)
DEPARTMENT OF NATURAL RESOURCES Division of Environmental Quality	S,R,E,I	Senate Bill No. 1, Section 1 (1974)	(administers Safe Drinking Water Act) (prepares Comprehensive State Water Plan) Water Quantity and Quality Research Programs State Water Conservation Program (administers State Water Development Fund)
Division of Geology and Land Survey			(cooperator for stream gaging and hydrologic studies)
PUBLIC SERVICE COMMISSION	E	MO Statutes, Chapter 393	(licenses water supply corporations)
		SOUTH OAKOTA	
DEPARTMENT OF ENVIRONMENTAL PROTECTION	E	SO Statutes	(administers Safe Drinking Water Act)
DEPARTMENT OF NATURAL RESOURCES DEVELOPMENT Division of Geological Survey	S,R,E,I	SO Statutes	(cooperator for stream gaging and hydrologic studies)
Division of Water Rights			Water Appropriation and Permit Program (cooperator for water development projects)
		WISCONSIN	
DEPARTMENT OF LOCAL AFFAIRS AND DEVELOPMENT	E,I	WI Statutes, Chapter 15	(administers State and Federal Assistance Program) (coordinates Disaster Relief Programs)
DEPARTMENT OF NATURAL RESOURCES	S,R,E,I	WI Statutes, Chapter 15	(administers Safe Drinking Water Act) Water Appropriation and Permit Program Water Supply Financial Assistance Program Surface Water Resources Report
GEOLOGICAL AND NATURAL HISTORY SURVEY	S	WI Statutes, Chapter 36	(cooperator for stream gaging and hydrologic studies)

[a]Scope of authority is defined as follows:
S= Statutory: research, collect information, coordinate, prepare plans
R= Regulatory: establish rules and regulations, issue permits
E= Enforcement: enforce laws and regulations
I= Implementation/Construction: administer funds, acquire land, construct and operate projects

Sources: Executive Office of the President, Office of Management and Budget, 1979 Catalog of Federal Domestic Assistance, May 1979.
Upper Mississippi River Basin Commission, FY 1978 Program Report of State and Federal Water and Related Land Resources Efforts, December 1978.
Upper Mississippi River Basin Commission, Upper Mississippi River Main Stem Level B Study, Technical Paper G: Legal and Institutional, August 1979. (draft)

Development. General Revenue Sharing and the granting of tax exempt status on interest of municipal bonds have also helped finance supply facilities.[4]

Federal water supply policies favor local development, but there is increasing federal involvement in water supply quality, conservation, and water resource monitoring. Federal regulations for protecting public health are fundamental in the Safe Drinking Water Act, Clean Water Act, and National Environmental Policy Act. Surface water and groundwater resources require protection from contamination by a myriad of chemicals that enter the water both through point and nonpoint sources. Pollution of groundwater aquifers is especially critical because of their extensive use in rural areas and the time needed to cleanse the supply. Water quality standards are established by these and other federal acts, but state and local governments generally pay the costs to comply with them. Some grants and loans are available through the Environmental Protection Agency and other agencies programs.

Water conservation was established as a national priority in the Presidential Water Policy message on June 6, 1978. Improved water use efficiency is recognized as a viable alternative for reducing requirements for further water supply development. During construction of federally-supported water projects, conservation is usually integrated into plan formulation and included in benefit and cost analysis. Although state and local governments are not forced to establish conservation programs for locally-funded projects, some conservation programs have been implemented in limited water resource areas with large water demands.

Water quantity and quality monitoring is a federal-state cooperative effort. Streamflows and groundwater levels are continually monitored throughout a national network of U.S. Geological Survey stations. The U.S. Geological Survey and Environmental Protection Agency also collect water quality information. Federal expenditures for water resources monitoring has accelerated because resource assessment is necessary to define water availability and quality for future needs and the effects of further project development on the resource. A total of $106 million has been appropriated for nationwide water resources investigations in FY 1980 for the U.S. Geological Survey. Of this amount, $34.6 million is for stream gaging, $6.8 million is for groundwater data acquisition, and $14.4 million is for water quality monitoring. States participate in these cooperative programs in addition to their own statewide monitoring programs.

While federal programs influence water supply development and water resource research, the states have a more dominant planning, management, and regulatory role. Water allocation in states of the Upper Mississippi Region traditionally has been governed by the riparian doctrine which is based on the concept that water use rights are usually associated with the ownership of the land. Where water resources are plentiful, few water use conflicts arise. But when resources are limited or are threatened by discharges after water use, some modifications for appropriating water according to reasonable use are necessary to allocate water fairly. For better water management, states have changed or are considering changing the traditional water laws.

In Illinois, some statutes promote reasonable use of water, but no legislation gives the state administrative control over water use. Ownership of riparian land allows the right of surface water and groundwater use even though court decisions have limited the rights of landowners based on reasonable use. Some water use regulatory authority lies with the Department of Transportation, Division of Water Resources in designated water resource management areas.

Administrative controls over the right to use water in Indiana has restricted use in some instances, but the courts have resolved most water use conflicts. Water rights are attached to land ownership but are limited to reasonable use with domestic purposes as highest priority. The Department of Conservation can restrict groundwater use when withdrawal exceeds natural recharge.

Iowa has the most comprehensive water permit system in the region. The Natural

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[4]Environmental Protection Agency, Office of Drinking Water, Water Supply-Wastewater Treatment Coordination Study, August 1979. (review draft)

Resources Council issues water use permits both from surface water and groundwater sources. Water rights are acquired when water is available and the use is beneficial without threatening the public interest or superior water rights. Daily withdrawals in excess of 5000 gallons require a permit except for ordinary household and livestock water uses, in addition to other beneficial uses within the territorial boundaries of municipal corporations existing on May 16, 1957.

A permit system for using surface water and groundwater has been adopted in Minnesota. The Commissioner of Natural Resources administers and controls the use and allocation of water. All users must apply for an appropriation and use permit except domestic uses serving less than 25 persons, and withdrawal for any use at a rate not to exceed 10,000 gallons per day and totaling no more than 1 million gallons per year. Priority is established with domestic uses first; small uses, consumption less than 10,000 gallons per day, second; agricultural irrigation and processing third; power production fourth; and larger uses, consumption greater than 10,000 gallons per day, fifth. Rules for appropriation of waters, containing standards and criteria for permit issuance were promulgated in August 1980.

The Missouri legislature has not modified the common law rules governing water use and withdrawal. Water rights are attached to land ownership, but a riparian owner cannot use water in a manner that will deprive other landowners of their rights. Resolution of conflicts has been a matter of judicial decision. Missouri courts have established a priority system where domestic use and livestock watering are favored over "artificial" uses such as manufacturing, irrigation, and recreation are second. Groundwater rights also appear to follow the rule of reasonable use, but the lack of legal precedent prevents defining specific rights.

South Dakota is the only state in the region which has water rights based on the appropriation doctrine. Water rights are acquired by applying to the Water Rights Commission of the Department of Natural Resource Development for a permit to appropriate water. The time of filing for a permit establishes the water right priority, but domestic use takes precedence over all appropriative rights. Appropriation of groundwater generally follows the same procedure.

Wisconsin has a permit system only for groundwater withdrawals greater than 100,000 gallons per day and for surface water diversions. Groundwater permits are issued by the Department of Natural Resources and can be denied only where the proposed well or wells will adversely affect or reduce the availability of water to any public water utility. Surface water diversions are permitted when the surplus water of a stream (water not beneficially used) is used to maintain the "normal level of any navigable lake or the normal flow of water in any navigable stream;" or when non-surplus water is used for agriculture or irrigation, provided the public rights in the stream and riparian rights are safeguarded (Wisconsin Statutes, Chapter 30, Section 18).

While states manage water use and development through permit programs and their planning and regulatory activities, local government is ultimately responsible for complying with regulations and developing new water supplies. Although financial assistance is sometimes available through federal and state programs, local funds are usually used for adding new treatment systems and for constructing additional or deeper wells. Local communities have combined to form regional commissions for delivering water to a larger service area when water resources limit development of numerous small supply sources. Better water management is generally achieved with these regional water systems because of regional supply monitoring. In addition conservation programs are often necessary to fulfill the allocation needs for the components of the system.

Alternative Solutions, and Effects

Within the Upper Mississippi Region, numerous small local water supply problems exist but the four following problems are the dominant issues.

(1) Water supply contamination. Contamination of both surface water and groundwater is increasingly evident throughout the region.

(2) Drought-induced water shortages.

Where most supply problems are local under normal precipitation, droughts can cause widespread regional shortages.

(3) Declining groundwater levels. Large groundwater pumpage, particularly for municipal or irrigation use, can lower water table levels creating conflicts with other users.

(4) Inadequate water information and management. The lack of water availability and quality data limits management capabilities.

Alternatives for solving water supply problems can be generally classified as development or conservation alternatives (Table II-3). Development of additional supplies is possible when water of adequate quality is available at reasonable costs. Constructing surface water reservoirs, drilling more or deeper wells, establishing regional water systems, recycling wastewater, and desalination are development alternatives that must be considered when problems develop. Although most capital costs and all operating expenses must be financed by the individual utility, some assistance in capital funding is available through federal and state programs.

Federal assistance for water supply development is possible in multi-purpose reservoir projects and through numerous grant and loan programs. For example, the Army Corps of Engineers and Soil Conservation Service can include water supply storage in multi-purpose reservoirs provided that the costs are totally repaid over the life of the project. If the federal government gave water supply storage direct cost-sharing or if the state and local government was allowed to use grant money for water supply storage, more reservoir water could be used for water supply. However, this shift in cost-sharing policy should be coordinated with a stringent conservation program to assure that only the areas of severe water deficit are willing to use this alternative. Identification and preservation of prime reservoir sites would help assure future water supply sources.

Dependability and adequacy of municipal drinking water supply are greater problems for smaller systems because local revenues may be insufficient to meet construction, distribution, and treatment costs. Fortunately, the Farmer's Home Administration and Economic Development Administration will provide grants and loans for these small systems. Nevertheless, additional assistance may be needed to meet the quality regulations of the Safe Drinking Water Act. Technical, planning, and management assistance from the Environmental Protection Agency and the states would improve the capabilities of small systems. Through Environmental Protection Agency grants to the National Rural Water Association, state rural associations are funded to provide training and technical assistance to small rural water systems.[5] Where local water resources are such that more conventional development alternatives are not possible, regional water systems, rural water districts, or recycled wastewater and desalination could be considered. Regional water systems will expand throughout the region but especially in the south and west where water resources are more limited. High-yield aquifers, rivers, new reservoirs, or reservoirs with expanded capacities will be the primary sources of regional supplies. Funding of these systems both by federal and state government is necessary to meet future water requirements.

Rural water districts could be established by landowners to provide an adequate water supply for domestic purposes when the landowners are not served by a municipal water system and cannot obtain adequate supplies from private wells. Individual water costs would rise, but this would assure a safer water supply for rural areas currently with groundwater contamination problems.

Recycled wastewater and desalination of poorer quality groundwater are two alternate supply sources where extreme supply problems exist. Further research on the effects and costs of recycled wastewater use, as well as on the likelihood of public acceptance is necessary. In certain areas, it may be desirable to

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[5]Environmental Protection Agency, Water Planning Division, Water Quality/Water Allocation Coordination Study, August 1979. (draft)

TABLE II-3. ALTERNATIVE SOLUTIONS TO WATER SUPPLY PROBLEMS AND NEEDS: ANALYSIS AND EVALUATION[a], UPPER MISSISSIPPI REGION

Alternative Solution (Problem Addressed)	Four Account Effects				Evaluation			Conclusion
	NED	EQ	RED	OSE	Planning Objective	Effi-ciency	Accept-ability	
(1) Enhance federal and state support for local development of wells or surface water where feasible to fulfill any municipal water requirements (Local supply problem)	- national cost + non-agricultural output	- water quality - instream flows	+ economic stability + water supply - state cost	+ emergency preparation	NED	Medium	Medium	Conditionally Recommended
(2) Provide water supply storage in federal reservoir projects through direct cost-sharing or through application of state and local grant money toward water supply storage in reservoirs (Water supply contamination; Drought-induced water shortages)	- national cost + non-agricultural output	- surface water quality - instream flows	+ economic stability + water supply - local cost	+ emergency preparation	NED	Low	Medium	Study
(3) Preserve prime reservoir sites for possible future use (Water supply contamination; Drought-induced water shortages; Declining groundwater levels)	- agricultural output - non-agricultural output	+ natural areas + erosion control	- local cost - state cost + flood damage reduction	+ recreation + emergency preparation	EQ	Low	Medium	Study
(4) Increase federal support to small water supply systems for improving supply and quality (Local supply problem; Water supply contamination)	- national cost + non-agricultural output	XX	+ economic stability + water supply	+ health and safety + emergency preparation	NED	High	High	Recommended
(5) Construct regional water systems that pump from high production aquifers or surface water sources (Local supply problem; Water supply contamination; Declining groundwater levels)	- national cost + non-agricultural output	- water quality - instream flows	+ jobs + economic stability + water supply - local cost - state cost	+ real income + health and safety + emergency preparation	NED	Medium	High	Conditionally Recommended
(6) Create rural water districts to provide good quality water for rural areas (Local supply problem; Water supply contamination; Declining groundwater levels)	+ agricultural output + non-agricultural output	- water quality - instream flows	+ jobs + economic stability + water supply - local cost	+ real income + health and safety + emergency preparation	NED	Medium	High	Conditionally Recommended
(7) Consider wastewater recycling at municipalities with severe water supply problems and desalination for areas with severe water quality problems (Local supply problem; Water supply contamination)	- national cost - non-agricultural output	+ surface water quality - instream flows	+ economic stability + water supply - local cost - state cost	XX	EQ	Medium	Low	Study
(8) Establish a federal conservation program that requires implementation of practical conservation measures before funding or construction, increases financial and technical assistance, and creates a lead conservation agency (Drought-induced water shortages; Declining groundwater levels)	- national cost + non-agricultural output	+ water quality + instream flows	+ economic stability + water supply - local cost - state cost	+ health and safety + emergency preparation	NED,NS	High	High	Recommended
(9) Implement state and local water conservation programs that incluoe disaster contingency plans (Drought induced water shortages; Declining groundwater levels; Water supply contamination)	+ agricultural output + non-agricultural output	+ water quality + instream flows	+ economic stability + water supply - local cost - state cost	+ health and safety + emergency preparation	NED,NS	High	Medium	Recommended
(10) Implement a state water permit system to assure supplies for priority users (Inadequate water information and management; Drought-induced water shortages; Declining groundwater levels)	XX	+ water quality + instream flows	+ economic stability + water supply - state cost	+ emergency preparation	EQ,NS	High	Medium	Recommended
(11) Increase programs that monitor water availability and quality (Inadequate water information and management; Water supply contamination; Declining groundwater levels)	- national cost	+ groundwater quality	+ water supply	+ health and safety	EQ,NS	High	High	Recommended
(12) Reduce groundwater contamination and exploitation through educational and technical programs and better interstate management (Inaoequate water information and management; Water supply contamination; Declining groundwater levels)	- national cost + agricultural output + non-agricultural output	+ groundwater quality + instream flows	+ economic stability + water supply - state cost	+ health and safety	EQ,NS	High	High	Recommended
(13) No action	- non-agricultural output	- groundwater quality - instream flows	- economic stability - water supply - local cost	- health and safety - emergency preparation		Low	Low	Not Recommended

[a]Abbreviations in the Table: NED (National Economic Development), EQ (Environmental Quality), RED (Regional Economic Development), OSE (Other Social Effects), NS (Nonstructural), XX (Not applicable)

For complete definition of Effects, Planning Objectives, Efficiency, Acceptability, and Conclusions see Appendix E.

investigate the economic feasibility of producing fresh water from brackish groundwater. Various methods of desalination include: distillation, electrodialysis, freezing, and reverse osmosis.

While the mechanism for water supply development is firmly established and only requires perhaps some modification in cost-sharing and in coordinating grants and loans, conservation requires greater federal, state, and local program coordination to encourage widespread implementation. Conservation is the protection of water resources through improved water use efficiency, better management and allocation, and preservation of the quantity and quality of the existing resources. Improved water use efficiency by all users would conserve existing water supplies and provide long-term economic and environmental benefits. Possible benefits of improved efficiency include the following:

(1) new water supply systems may be postponed or eliminated;
(2) higher energy costs of supplying water may be reduced and efficient use of hot water could further reduce energy consumption;
(3) new construction of wastewater treatment facilities may be postponed because existing plant wastewater treatment capacities may be sufficient;
(4) competition for water during critical water shortages could decline;
(5) a leak monitoring and control program for distribution systems could reduce repair costs caused by leaks and system age; and
(6) instream flows and groundwater levels may be not as severely influenced by excessive withdrawals in certain areas.

Federal policy encourages improved efficiency, particularly since the President's Water Policy Message of June 1978 directed that water conservation become a consideration in all federal programs and projects that affect water supply. Federal agencies now encourage appropriate community water conservation measures in water supply grant and loan programs for water supply storage in federal projects, and provide technical assistance on conservation. However, no lead agency has been directed to coordinate the conservation programs. Draft legislation has been prepared to provide $25 million matching funds to states for implementing technical assistance programs.

State and local government have encouraged water savings when droughts limit supplies or when supplies are limited. The most effective local conservation programs in the region have been already implemented in some municipalities in the Chicago area. Programs generally include modification of water rate structures, changes in the plumbing code, a retrofit program, and a public information campaign. Public awareness of water-saving techniques is instrumental in any conservation program and requires a proportional share of funding to reach the public.

Water use efficiency in agriculture and energy can also be improved. Irrigation is an extremely consumptive water use, but some alternatives could reduce withdrawals. Landowners should have a water conservation plan before irrigation systems are installed. The local soil and water conservation district can determine the water holding capacity of the soil, the water demand of specific crops, and the best method of water application and the amount necessary.

Energy water use is currently inefficient with large withdrawals and little comsumption, but further compliance with the Clean Water Act will ensure greater water reuse. Greater water reuse will increase water consumption and reduce the amount of water returned to streams which could create flow problems during low flows. Dry-cooling towers would remedy this situation but are currently too costly for widespread installation. Technological improvements are necessary to improve energy efficiency and cost effectiveness.

Besides improved water use efficiency, better management and allocation of water can effectively conserve water. During shortages, a water permit system could be implemented which would restrict water use according to a priority system. Regional water sources must be assessed

because priorities should be established on an aquifer basis. To establish a water permit system additional state legislation may be needed that would have strict allocation guidelines. Essential water supplies for domestic and livestock uses would be preserved during a severe water emergency and other water users would be guaranteed a water supply. A disaster contingency plan, which would include normal conservation practices and an emergency rationing plan, could also be required for municipalities and rural water districts. States have the primary responsibility in these endeavors and are at various stages of progress in the region. But a coordinated study that details the consequences of a severe drought and focuses on specific problem areas would help states in determining planning needs for water management and allocation.

Preservation of the quantity and quality of existing water resources is essential in all water planning. Policies that preserve surface water resources have been developed at all government levels, but groundwater management policies have lagged. States have had the primary responsibility for policy development, but actual policy development has been accomplished with different degrees of success. The federal government has recently expanded its interest in groundwater. Federal programs and projects that affect groundwater could be required to have a more thorough environmental evaluation for a revised "Principals and Standards" analysis or for the National Environmental Policy Act process. Technical and financial assistance through the Clean Water Act, Safe Drinking Water Act, Resource Conservation and Recovery Act, Surface Mining Act, Toxic Substance Control Act, and U.S. Geological Survey planning funds can encourage states to improve groundwater management systems.

Other alternatives for management would involve better federal-state and interstate coordination of programs. Creation of a National Groundwater Advisory Commission would provide a forum for federal agencies and states to resolve problems.[6] River Basin Commissions could also coordinate region-wide groundwater planning and act as an intermediary for interstate conflicts.

Conclusion

Implementation of the water development alternatives would generally provide water supplies for further economic growth. These development alternatives are not recommended for regional implementation but are necessary at some sites that have severe supply problems. Although federal, state, and local costs would increase, the economic benefits of having a safe and secure water supply may offset monetary costs and potential environmental drawbacks.

The water conservation alternatives would encourage more efficient use and management of water resources thus stressing an environmental objective. Long-term economic stability would be also accrued without large investments for construction. Regional implementation is recommended for all conservation related alternatives.

Without the implementation of any alternative in water supply planning (no action), the primary responsibility for supply development will remain with local government, and conservation programs will lack the support for widespread implementation. Costs for constructing and treating water supplies will increasingly exceed local fiscal capabilities because resources are often less accessible and drinking water standards are more stringent. Poor water management will spawn more conflicts between various water users and perhaps states. Other water quality and instream flow objectives cannot be accomplished in many instances unless water supplies are efficiently managed.

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[6]Federal Water Policy Initiatives, Environmental Quality and Water Resources Management, Report of Task Force, Groundwater Supply--Federal-State Cooperation, June 4, 1979.

WATER QUALITY

Current Conditions and Problems

Water quality problems in the Upper Mississippi Region are generally not severe although nonpoint source pollution is pervasive. Point source pollution problems are localized and are the result of municipal and industrial wastes and feedlot runoff. The greatest pollutants by volume are sediments which originate from erosion both on agricultural and urban lands. Sediments cause turbidity and are a problem because the fine grained particles adsorb pesticides and nutrients and carry them into the waters. Municipal and industrial sources cause significant pollution problems in urban areas because they discharge organic material, heavy metals, and other compounds. Thermal pollution is sometimes a problem below steam-powered electrical generating facilities.

Water quality problems are dispersed throughout the Upper Mississippi River Basin but their magnitude varies greatly among subregions (Figure II-3). Conditions that affect pollution are sometimes locally unique. The severity of water quality problems are relative to the general conditions affecting a particular river basin. For example, a water quality problem in the Saint Croix River Basin may not qualify as a problem in the Upper Illinois River Basin because most streams in the Saint Croix River Basin have a higher quality level than in the Upper Illinois River Basin.

Water quality is defined in terms of the physical, chemical, biological, and bacteriological characteristics of the water and stream bed. These natural characteristics are influenced by the geology and climate of the area, streamflows, and various types of water discharges. Water quality is affected by numerous natural and man-made factors. In the subregions most affected by urbanization, human-related factors are likely to be the primary influence in governing water quality conditions. In all subregions, physical factors such as water depth, flow volume and velocity, and soil and geologic material, also influence water quality.

The quality of a body of water must be considered for its intended use. Water quality suitable for fish and wildlife habitat varies for different species. Different qualities of water are suitable for different applications in home, agriculture, and industry. Water quality varies between streams and within a stream thus making it difficult to assess quality at any particular location.[7]

Excessive suspended solids creating turbidity are the most common water quality violations. These solids are generally the result of land erosion which is occurring at unprecedented rates throughout the region and the nation. Suspended sediments are severe in the Black-Root, Iowa-Skunk-Wapsipinicon, Rock, Des Moines, Salt-Sny, Lower Illinois, and Kaskaskia-Meramec river basins. The predominately agricultural nature of these areas has accelerated the erosion process and has caused soils to be suspended and deposited in the region's waters.

Sediment yields in the northern portions of region range from 10 to 500 tons per square mile annually. In the southern portions of the region annual sediment yield is sometimes greater than 6000 tons per square mile. Suspended sediment in the Mississippi River increases significantly down river. Daily suspended sediment load is 12,700 tons at Dubuque, Iowa while 36,700 tons pass Keokuk, Iowa daily.[8] Below the confluence of the Missouri River the suspended sediment in the Mississippi River is significantly increased. An average of 370,000 tons of suspended sediment pass St. Louis, Missouri daily.[9] The major sources of this sediment are cropland, construction sites, streambanks, and mined areas which are unprotected from the natural forces of rain and wind. A large percentage of this eroded material remains suspended

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[7] Iowa Natural Resources Council, Iowa Water Plan '78, July 1978.

[8] Great River Environmental Action Team, GREAT II Sediment and Erosion Control Work Group Appendix, 1980. (draft)

[9] U.S. Army Corps of Engineers, Preliminary Reconnaissance Report GREAT III, June 1979.

FIGURE II-3. WATER QUALITY PROBLEM AREAS*, UPPER MISSISSIPPI REGION

*Water quality information for the Upper Mississippi Region is not uniform because of state differences in data collection. Problem areas on this map are only general indications of water quality conditions and are not relative measures of severity.

Sources: Illinois Environmental Protection Agency, *Illinois Water Quality Inventory Report,* 1976.
Iowa Department of Environmental Quality, *Iowa Water Quality Report,* 1977.
Minnesota Pollution Control Agency, *Minnesota Water Quality,* 1977.
Missouri Department of Natural Resources, *Water Quality Report,* 1977.
Wisconsin Department of Natural Resources, *Wisconsin 1977 Water Quality Inventory.*

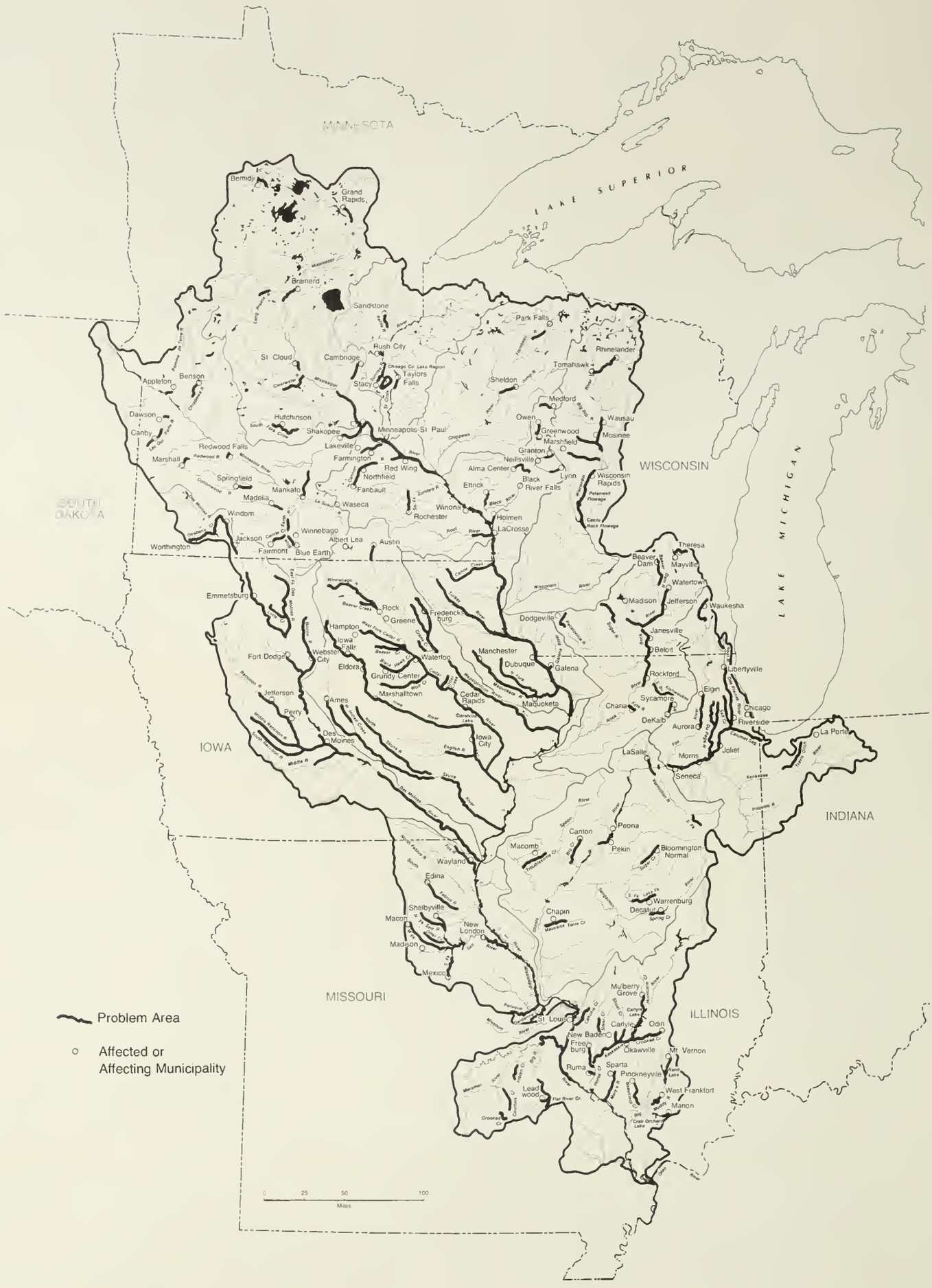

FIGURE II-3. WATER QUALITY PROBLEM AREAS*, UPPER MISSISSIPPI REGION

*Water quality information for the Upper Mississippi Region is not uniform because of state differences in data collection. Problem areas on this map are only general indications of water quality conditions and are not relative measures of severity.

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Iowa Department of Environmental Quality, *Iowa Water Quality Report,* 1977.
Minnesota Pollution Control Agency, *Minnesota Water Quality*, 1977.
Missouri Department of Natural Resources, *Water Quality Report,* 1977.
Wisconsin Department of Natural Resources, *Wisconsin 1977 Water Quality Inventory.*

in the water causing a host of water quality problems. Fish and aquatic habitat degradation, accelerated eutrophication, and water supply contamination are some of the problems associated with suspended and deposited sediments.

Phosphorous and nitrogen fertilizers are usually incorporated into the soil during application. Although both elements can enter water courses through the sediment transport mechanism, applied nitrogen is usually not available at the surface for this movement. Ammonium ions may be adsorbed on soil particles but more often are converted to nitrate by microbial action and leached downward. Nearly all phosphorous enters the water as a structural constituent of organic or mineral particles or as ions adsorbed on the surfaces of solid particles. Although plant residue is the source of most phosphorous and nitrogen, fertilizers carried by sediments are suspected of causing excessive phosphorous and nitrate levels in streams and public water supplies. Commercial fertilizer application averages about 150 pounds per cropland acre in the region.[10]

Municipal and industrial wastewater treatment facilities, feedlots, dairy plants and pulp mills, discharge pollutants which contain biochemical oxygen demand (BOD) and chemical oxygen demand (COD) in excess amounts with the result that standards for dissolved oxygen (DO) are commonly violated. Particularily affected are areas downstream of larger metropolitan regions such as Minneapolis-St. Paul, Chicago, Des Moines, Madison, and St. Louis. Urban and nonurban areas downstream in the Mississippi Headwaters, Maquoketa-Plum, Wisconsin, Upper Illinois, and the Kaskaskia-Meramec river basins are also affected although less severely. Organic and chemical discharges from these operations require oxygen to breakdown the materials into inert matter. This process often reduces the oxygen supply available in the water and hence destroys its capability to support aquatic life, limits its use as a water supply, causes repugnant odors, creates health hazards, and may contaminate other water supplies including underground aquifers.

[10]U.S. Department of Commerce, Census of Agriculture, 1974.

A combination of inefficient wastewater treatment plant operations and combined sewers cause persistent problems throughout the region. When overflows occur during storms, public health is threatened by degraded water quality as a result of untreated or partially treated sewage being discharged directly into waterways. In the Upper Illinois overflows occur on the average of once every four days.

Point source pollution problems will diminish when existing plans for the improvement of wastewater treatment facilities are implemented in accordance with the Clean Water Act. Assuming there are at least 260 Step 3 projects in Illinois, approximately 800 Step 3 municipal wastewater treatment projects are awaiting construction (Table II-4). Some municipalities are experiencing high infiltration rates into older and deteriorated wastewater treatment systems, because of the presence of combined sewers and high water tables. The presence of high levels of inflow into a treatment plant can hydraulically overload the system diluting the waste too much for efficient treatment. Systems are designed to handle specific flow and waste concentrations and changes in these conditions reduces system efficiency. An integral component of the wastewater treatment facilities plan is the upgrading of sanitary and storm sewers, which will

TABLE II-4. MUNICIPAL WASTEWATER TREATMENT PROJECTS,[a] UPPER MISSISSIPPI REGION

State	Step 1 Projects	Step 2 Projects	Step 3 Projects	Municipalities with Combined Sewers
Illinois[b]		-953-		92
Iowa	7	190	219	17
Indiana	3	21	22	8
Minnesota	69	75	43	13
Missouri	2	38	52	3
South Dakota				0
Wisconsin	123	177	204	5
REGION TOTAL				138

[a]Step 1 - Facility Planning
Step 2 - Preparation of Plans and Specifications
Step 3 - Construction

[b]All Step 1, 2, and 3 projects in the Illinois portion of the subregion are grouped together.

Sources: Illinois Environmental Protection Agency, Illinois Waste Water Treatment Facilities Municipal Project Priority List FY 1979.
Indiana State Board of Health, Division of Water Pollution Control, FY 80 Municipal Project List.
Iowa Department of Environmental Quality, State of Iowa FY 1979 Construction Grant Fundable Project List.
Minnesota Pollution Control Agency, State of Minnesota Municipal Project List 1979.
Missouri Department of Natural Resources, Construction Grants Expanded Priority Lists Fiscal Year 1979.
Wisconsin Department of Natural Resources, Project Priority List for Municipal Treatment Projects, Fiscal Year 1979.

significantly improve treatment plant efficiency. However, even with the completion of these projects significant improvement in ambient water quality may not result because of the severity of nonpoint source pollution.

Some locally severe water quality problems are a result of improper septic tank operation. Malfunctions or improper installation of these systems are generally the cause. The expansion of sewer lines has occurred in urban fringe areas when drainfields were over saturated as in areas of the Saint Croix, Wisconsin, and Upper Illinois river basins. However, in undeveloped areas sewer line expansion may not be an environmentally or economically sound alternative.

Several water quality problems occur as a result of toxic materials which include heavy metals, polychloronated biphenals (PCBs) and pesticides. These contaminants pose severe health threats to residents of the region and usually restrict the use of the area waters which includes prohibiting fish consumption. Potentially toxic materials in river water and river sediments can act alone or synergistically threaten the integrity of the aquatic food chain and the potability of the water. Disposal of dredged materials or any other practices which would modify the aquatic environment could adversely affect the habitat of the river benthos, thus undermining the food supply as well as the spawning areas of river fishes.[11]

Unacceptable levels of PCBs have been found in the Mississippi River from Minneapolis-St. Paul to St. Louis. Although the higest PCB levels have been found immediately below Minneapolis-St. Paul to Lake Pepin, the urban areas of Davenport and St. Louis are also significant contributors to PCB contamination in fish flesh.[12] Mercury violations have been found in the Chippewa and Illinois rivers. Copper, lead, iron, and manganese violations occur in the Illinois, Kaskaskia, and the Salt river basins. Cadmium, copper, and zinc violation have occurred in the Meramec River Basin as a result of mining operations. In addition, leaching from coal mining operations in Illinois sometimes causes violations of acidity standards in local waters.

The occurrence of detectable levels of pesticides is widespread. The large number of conditions and variables involved, however, make it impossible to predict accurately the net contribution of pesticides to area waters. Illinois and Missouri have set specific limits for pesticides in their waters. Minnesota and Wisconsin have adopted limits in reference to U. S. Environmental Protection Agency (USEPA) water quality criteria. Iowa has not set specific limits for pesticide concentrations in state waters. Insecticide contamination in the region's waters is not uncommon. In the Root River Basin in southeastern Minnesota insecticides used on crops are suspected of killing thousands of trout, although, there is a lack of conclusive evidence.[13]

In groundwater, as in the case of surface water, quantity and quality are interrelated. Pumping groundwater from wells near a stream may in effect be a diversion of flow from the stream. Conversely, reduction of streamflow by an upstream diversion may reduce the recharge of an aquifer. Therefore the water quality of a stream can have a direct effect on the quality of groundwater.[14]

The seepage of contaminated surface water into fractured limestone aquifers is a problem in southeastern Minnesota, southwestern Wisconsin, and northeastern Iowa. The quality of groundwater is directly affected by the quality of water which recharges the aquifer. Recharge of groundwater with polluted water can occur in several ways: (1) injection of

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[11]U.S. Army Corps of Engineers, op. cit., footnote 9.

[12]T. F. Lorenze, U.S. Environmental Protection Agency, Region VII, Summary Report of the Occurrence of PCB Fish Flesh Contamination in the Rivers and Streams of Region VII, Surveillance and Analysis Division, Kansas City, Kansas, 1976.

[13]Nick Coleman, "Insecticides Blamed for Killing Thousands of Fish Each Spring," Minneapolis Tribune, 23 November 1979.

[14]U.S. Environmental Protection Agency, Water Supply-Wastewater Treatment Coordination Study, August 1979. (draft)

polluted water into the aquifer through a waste disposal well, (2) percolation from land disposal systems for wastewater, (3) percolation from a polluted stream, (4) runoff from livestock feeding areas, (5) leaching of salts from irrigated farm land, (6) leaching of salts from land fills, (7) seepage from solid wastes, or (8) deliberate recharge of an aquifer with storm or reclaimed water to augment the groundwater supply. Chemicals applied to the land may also be washed into an aquifer with percolating water. This can occur on agricultural land where the watertable is close to the surface. Wastewater cesspools and septic tanks can also lead to pollution of the groundwater.

Groundwater contamination is recognized as one of most significant threats to the region's (and nation's) water supplies. Several areas in the region have been identified as locations where hazardous wastes have been illegally or improperly dumped and are now causing contamination problems. Recent enactment of the Resources Conservation Recovery Act may provide a vehicle to prevent future hazardous waste abuses and subsequent contimination problems. Meanwhile the federal government will provide money through the "superfund" to clean up the most dangerous sites and those areas where the violation cannot be determined.

Coal mining is an important economic activity in the Illinois, Iowa, and Missouri portions of the region. Drainage from active mine sites, wastewater from coal preparation areas, and sediment loading from the reclamation lands can cause surface water pollution. In some areas, groundwater pollution may occur because of coal extraction and related processes.

The worst surface water pollution in the region may occur from storm runoff because pollutants on the ground or vegetation can be washed into the waterways. Sediment is the most common pollutant, but agricultural chemicals, rubber, oil, and grease from cars, and any other material which may have accumulated on the ground can be present. Commonly, sediment which is available in unlimited quantities increases as flows increase. Other pollutants present in limited quantities may be largely removed from the land by a moderate rain and, hence, do not increase indefinitely with increasing flow rates.

Thermal pollution occurs on rivers below power plants throughout the region. Stream temperatures and velocity are considered to be the two variables which influence most the stream's character. Temperatures greatly influence species population and diversity and therefore effect the rivers resource value. Fish in the Mississippi River are probably less affected because of its large flow volume which assimilate the thermal pollutant. Although the effects of thermal pollution on fish are generally known, the magnitude of the problem is not.

The assimilative capacity of a stream can decrease pollutant levels in several ways. As water flows through a stream system some pollutants may settle to the stream bed and be temporarily removed from the water. Other pollutants may be taken up by vegetation or aquatic life and removed from the water. Oxygen, absorbed through the stream surface, may help to satisfy oxygen demand. Depletion of streamflow for offstream use will generally reduce the assimilative capacity and the rate of self purification.

Anticipated Problems

The effect of a particular pollutant depends on the nature of the contaminant, the levels at which it is present, and the effectiveness of treatment methods. Relative pollutant contributions for nonpoint and point sources will continue to vary among subregions depending on land use, geology, climate, and other factors. Point source pollution is the most readily identifiable pollution type. Urban and industrial discharges are major contributors to this pollution problem and most efforts have been aimed at reducing or eliminating pollution from these sources. Point source contaminants usually include bacteriological pollution, heavy metals, and thermal pollution. The regions water quality will be significantly improved when municipal, industrial and agricultural wastewater facilities are upgraded or replaced in accordance with the 1977 Amendments to the Clean Water Act.

All waters will continue to be affected to some degree by nonpoint source pollution. Nonpoint source pollution problems are more difficult to

identify and resolve than are point source pollution problems. Pollution from nonpoint sources includes decaying vegetation, salts dissolved from the rock and soil, sediment, pesticides, fertilizers and other chemicals introduced by agriculture and silviculture, street storm runoff, and various compounds from mine drainage. Agricultural pollution which is a major component of nonpoint source pollution, is extensive and will continue to be difficult to control. Fertilizer and pesticide application on agricultural land will continue to cause nutrient contamination, health problems, and accelerated eutrophication in water bodies. With an increased number and size of livestock feeding operations, agricultural pollution will remain a threat to many rivers and streams. Urban runoff, also a major component of nonpoint source pollution, sometimes contains excessive concentrations of salts and metals, and substantially degrades water quality. Some problems will remain as a result of mining activities.

The magnitude of nutrient and bacterial contamination from nonpoint sources may not make the 1983 goals of the Clean Water Act attainable or practical. Implementation of recommendations from the areawide and statewide 208 Water Quality Management Plans should substantially improve water quality. Some of these recommendations, termed "Best Management Practices" (BMPs) are designed to reduce or eliminate pollution such as silt, chemicals, and animal wastes at the source. Substantial funding increases are needed in order to implement the Rural Clean Water Program effectively.

Many natural conditions affecting water quality will remain unchanged in the future. Point source pollution is more evident during low streamflow periods. Nonpoint source pollution will continue to be more pronounced when precipitation is more abundant. When good streamflows occur dilution reduces point source impacts but nonpoint sources become more evident because of runoff. Under natural conditions the water quality in a stream will often be at its poorest near the end of a summer dry spell when streamflow is low and temperatures are high.[15] During warm periods, oxygen levels are lower because the saturation levels are lower and consumption rates increase.

The potential for acid rain contamination has been identified as one of the greatest environmental problems of the next decade.[16] Acid rain is the result of sulfur and nitrogen oxide emissions from internal combustion engines and smokestacks of energy and industrial complexes. Although no conclusive evidence has yet been found in the region, acid rains may be subtly destroying aquatic life in some areas. Investigations currently underway in Wisconsin may provide more evidence to determine the severity of the problem.

Governmental Authority, Responsibility, and Policy

Water quality management and planning have received much attention in recent years. The original Federal Water Pollution Control Act of 1948 established a mechanism for cleaning up contaminated rivers and lakes and provided grants and loans for research, planning, and construction. Amendments to this Act in 1956, 1961, 1965, and 1966 strengthened the federal role in water pollution control by setting water quality standards and providing for their implementation and enforcement.

As amended in 1972 (P.L. 92-500), this act is the basis for current water pollution control programs. The 1972 amendments set goals of attainment of fishable and swimmable waters by July 1983, and for elimination of the discharge of pollutants into the nation's waters by 1985. This act greatly expanded the role of the U.S. Environmental Protection Agency (USEPA) in water pollution control and increased the level of funding for state programs and construction of publicly-owned wastewater treatment plants.

In December 1977, this Act was again amended and renamed the Clean Water Act. These amendments do not substantially alter the main thrust of the Act, and the regulatory approach to water pollution

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[15] U.S. Environmental Protection Agency, op. cit., footnote 13.

[16] Al McConagha, "EPA Study of Acid Rain Threat to Environment Gets Top Priority," Minneapolis Tribune, 8 October 1977. P.2-B.

control remains essentially the same.

Effluent limitations are defined for discharges through the National Pollution Discharge Elimination System (NPDES) permit program authorized under Section 402 of the Clean Water Act (CWA) (Table II-5). Discharge limitations are defined by the USEPA under Title III of the CWA for various classes of dischargers (e.g. best available treatment, new source limits, secondary treatment, etc.). Permits are generally given for periods of five years and consist of limitations on volume and concentration of pollutants and schedules of compliance. Sometimes, operating procedures are also specified. Authority for administering the permit program has been transferred from the USEPA to state agencies in Illinois, Indiana, Iowa, Minnesota, Missouri, and Wisconsin. NPDES permits are administered by the USEPA in South Dakota. The USEPA retains authority to review individual permits issued by states for consistency with the Clean Water Act.

Section 404 of the Clean Water Act establishes a permit program for discharges of dredged or fill material. Activities regulated by this program include the construction of dams, diversions and impoundments, the filling of wetlands, and the disposal of dredged spoil. The 404 permit program is presently administered by the Army Corps of Engineers, although the CWA authorizes transfer of this responsibility to the states. Permit applications are evaluated for compliance with environmental guidelines developed by USEPA, in conjunction with the U.S. Army Corps of Engineers and U.S. Fish and Wildlife Service.

Section 201 of the Clean Water Act authorizes federal grants for planning, building, and improving publicly-owned sewage treatment works and sewers. Federal financial assistance is available for three steps: (1) planning the facilities, (2) design specifications, and (3) actual construction. The program is jointly administered by USEPA and the states. However, the USEPA is authorized to delegate many of its responsibilities for administering the program to the states.

The federal grants may be for as much as 75 percent of the project costs or 85 percent for innovative or alternate technology projects. Municipalities must provide remaining funds. In Minnesota, up to 15 percent state funding is available for the nonfederal share. Wisconsin and Illinois can provide state money instead of federal money for construction grants.

Water quality management planning is established under a variety of programs in the Clean Water Act. Section 303(e) provides for the states continuing planning process, which includes implementation of water quality standards. Section 208 establishes areawide waste treatment management planning, which provides for control of all sources of pollution, point and nonpoint, to the extent practicable. Plans are developed either by areawide agencies designated by the state or by the state itself in areas which have not been designated. All states have completed and approved their water quality management plans. Seven regional plans (areawide) have also been approved.

Section 208 provides for states and local governments to establish programs to control nonpoint sources of pollution. Nonpoint sources can include runoff from activities such as agriculture, forestry, mining, construction, urban stormwater, and residual wastes. States reserve the responsibility for planning for nonpoint sources from areawide agencies.

The major focus of point source pollution abatement has been on controlling the water quality discharge from municipal and industrial wastewater treatment plants. As the means to determine the level of treatment needed for maintaining water quality where technologic effluent limits will not provide for meeting water quality standards, wasteload allocation studies have been done. These studies determine the amount of discharges permitted by each treatment plant in order to meet water quality standards for the 7-day 10 year low flow of the stream into which the effluent is being discharged.

In addition to the USEPA, the U.S. Department of Agriculture addresses water quality through their soil and water conservation efforts. The Soil and Water Conservation Program (Conservation Operations) of the Soil Conservation Service (SCS) provides technical assistance to farm producers for the installation of conservation measures. The Agricultural Conservation Program of the Agricultural Stabilization and Conservation Service (ASCS) provides the cost-sharing funds

TABLE II-5. GOVERNMENTAL AUTHORITY AND RESPONSIBILITY FOR WATER QUALITY, UPPER MISSISSIPPI REGION

Agency		Authority[a]	Primary Program (function)
		U.S. GOVERNMENT	
DEPARTMENT OF AGRICULTURE			
Agricultural Stabilization and Conservation Service	I	Soil Conservation and Domestic Allotment Act as amended	Agricultural Conservation Progarm (grants for critical soil water, and pollution abatement)
	I	Federal Water Pollution Control Act as amended (P.L. 92-500)	Rural Clean Water Program (technical and financial assistance for installation of Best Management Practices)
Farmers Home Administration	I	Consolidated Farm and Rural Development Act (P.L. 92-419)	Soil and Water Loans Program
	I	Watershed Protection and Flood Prevention Act as amended	Watershed Protection and Flood Prevention Loans
Soil Conservation Service	I	Soil Conservation Act of 1935	Resource Conservation and Development Program (grants and advice for water management, water supplies, and water quality control)
			Soil and Water Conservation (technical assistance)
			Inventory and Monitoring Program (technical information on specific soil, water and related land changes)
	I	Watershed Protection and Flood Prevention Act (P.L. 83-566)	Watershed Protection and Flood Prevention Program (grants and technical services for planning and installation of watershed improvement works)
			River Basin Surveys and Investigations
DEPARTMENT OF THE ARMY			
Corps of Engineers	E,I	River and Harbor Act of 1962 as amended	Beach Erosion Control Projects (assures water quality criteria are met for contact recreation)
	I	Water Resources Development Act of 1974	Planning Assistance to States
	R,E,I	Clean Water Act, Section 404	(dredged materials disposal permits)
DEPARTMENT OF COMMERCE			
Economic Development Administration	I	Public Works and Economic Development Act of 1965 (P.L. 89-136 as amended)	Economic Development-Grants and Loans for Public Works and Development Facilities
DEPARTMENT OF HEALTH AND HUMAN SERVICES			
National Institutes of Health	S	Public Health Service Act (P.L. 78-410 as amended)	Environmental Health Research Manpower Development Resources (research grants for health related water pollution problems)
DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT			
New Communities Development Corporation	I	Housing and Urban Development Act of 1970 (P.L. 91-609 Title VII)	New Communities-Loan Guarantee (construction of water and sewer lines)
Community Planning and Development	I	Housing and Community Development Act of 1974 (P.L. 93-383 Title I)	Community Development Block Grants/Entitlemant Grants (pulbic works facilities)
DEPARTMENT OF THE INTERIOR			
Bureau of Indian Affairs	I		(water resource project funding)
Geological Survey	S		Water Resources Investigation (federal-state cooperative program)
Office of Water Research and Technology	S	Water Resources Research Act of 1964 (P.L. 88-379 Title I-II as amended)	Water Resoruces Research-Assistance to State Institutes
			Water Resources Scientific Information Center (technical information)
Fish and Wildlife Service	R,I		(maintenance and improvement of water habitats)
DEPARTMENT OF TRANSPORTATION			
United States Coast Guard	E,I	-----	(maintain and improve the quality of the marine environment, pollution discharge abatement)
Federal Highway Administration	I		(minimize soil erosion, abate water pollution from highway construction)
ENVIRONMENTAL PROTECTION AGENCY			
	I	Clean Water Act	Construction Grants for Wastewater Treatment Works
	I		Water Pollution Control-State and Interstate Program Grants (water quality planning, surveillance and enforcement)
			Water Pollution Control-State and Areawide Water Quality Management Planning
			Water Pollution Control-Lake Restoration Demonstration Grants
	S,R,E	Clean Water Act, Section 404	Wetlands Disposal Program
			(standards, effluent limits, permit programs)

TABLE II-5. (Continued)

Agency		Authority[a]	Primary Program(function)
	R,E	Federal Insecticide, Fungicide, and Rodenticide Act	(requires registration of pesticides, classification for use, certification of restricted use pesticides, accurate labeling, producer investigations)
	S,R,E	Toxic Substances Control Act P.L. 94-469 1976	(authorizes EPA to obtain data on production, use and effects of toxic substances, EPA may regulate their manufacture and distribution)
	S,R,E	Resource Conservation and Recovery Act P.L.94-580, 1976	(development of management plans and facilities for resource recovery and manage hazardous wastes)
Office of Research and Development	S	Public Health Service Act as amended	Safe Drinking Water Research and Demonstration Grants
SMALL BUSINESS ADMINISTRATION	I	Small Business Act as amended by P.L. 92-500	Water Pollution Control Loans
		ILLINOIS	
COMMERCE COMMISSION	R	IL Statutes, Chapter III 2/3	(regulates water and sewer utilities)
DEPARTMENT OF AGRICULTURE Division of Natural Resources	S,R,I	IL Statutes, Chapter 5	(administers Soil and Water Conservation Districts Act) (promulgates guidelines for sediment control and assists in watershed planning)
DEPARTMENT OF MINES AND MINERALS	R	-----	(protect surface and groundwater from mining operation)
	R,E	Surface Mining Control and Reclamation Act of 1977	(implement provisions of the Act)
DEPARTMENT OF TRANSPORTATION Division of Water Resources	E,I	IL Statutes, Chapters 19 and 127	(cooperates with federal agencies in water resources planning)
ENVIRONMENTAL PROTECTION AGENCY	E,I	IL Statutes, Chapters 19 and 127	(control, prevention and abatement of water pollution in all state waters including the construction of wastewater control facilities)
Division of Water Pollution	R,I	Federal Water Pollution Control Act	(certification nonpoint source controls, water quality management planning, facilities planning, NPDES permits)
Division of Public Water Supply	R,I	Safe Drinking Water Act	(operation and quality of public water supplies)
INSTITUTE OF NATURAL RESOURCES	S	IL Statutes, Chapter 127	(surface and groundwater quality data collection)
POLLUTION CONTROL BOARD	E	IL Statutes, Chapter 111.5	(determines, defines, and implements water quality rules and regulations, adopts standards, and hears violation complaints)
WATER RESOURCES CENTER	S	Water Resources Research Act of 1964 as amended	(water quality research)
WATER RESOURCES COMMISSION	S	IL Statutes, Chapter 19	(study progress and problems of water pollution)
		INDIANA	
DEPARTMENT OF NATURAL RESOURCES Division of Water	S	IND Statutes	(studies and investigations of multipurpose water projects and water resource problems)
State Water Plan Section			(state water planning)
STATE BOARD OF HEALTH Division of Sanitary Engineering			(review and approve plans for the sanitary aspects of water supplies)
Division of Water Pollution Control			(inspect and assist in operation of wastewater treatment plants)
STREAM POLLUTION CONTROL BOARD	R		(control and prevent pollution of waters and review plans)
ENVIRONMENTAL MANAGEMENT BOARD			(protect and enhance water quality)
CONSERVANCY DISTRICTS	S,R,E,I	IND Conservancy Act 1957	(treatment and sewage disposal)
		IOWA	
DEPARTMENT OF ENVIRONMENTAL QUALITY Water Quality Commission	E,I	IA Statutes, Chapter 455B	(sets water quality standards, prepares water quality management plans, programs, and facility grants NPDES permits)
DEPARTMENT OF HEALTH	E		(sanitary aspects of sewage disposal and water supplies)
DEPARTMENT OF SOIL CONSERVATION	I,S	IA Statutes, Chapter 83A and 467A	(supervises surface mining and requires adherence to acid spoil drainage specifications, administers soil conservation funds)
COMMERCE COMMISSION	R,E	IA Statutes, Chapter 474, 476A	(assures minimal adverse affects of power plants on water quality)
NATURAL RESOURCES COUNCIL	R	IA Statutes, Chapter 455A	(enforces regulations to protect surface and groundwater quality, comprehensive water plan)

TABLE II-5. (Continued)

Agency	Authority[a]		Primary Program(function)
		MINNESOTA	
DEPARTMENT OF AGRICULTURE	R	MN Statutes, Chapter 17	(disseminate information on water quality problems and pesticide regulations)
DEPARTMENT OF HEALTH	E	MN Statutes, Chapters 115,144,156A	(regulates water supply and waste treatment facilities)
DEPARTMENT OF NATURAL RESOURCES	S	MN Statutes, Chapters 83,84,85,87 89,92,93,97,98,99,104,105,111 112,282,378	(planning and technical assistance)
POLLUTION CONTROL AGENCY	S,R	MN Statutes, Chapters 115,116,116A	(pollution control monitoring, set standards, and enforcement and compliance, NPDES permits, planning)
SOIL AND WATER CONSERVATION BOARD	S,I	MN Statutes, Chapter 40	(disseminate information, administer cost-sharing funds)
SOUTHERN MINNESOTA RIVERS BASIN BOARD	S	MN Statutes, Chapter 114A	(comprehensive watershed planning)
WATER PLANNING BOARD	S	MN Statutes, Chapter 105	(coordination and participation in water resource management planning)
		MISSOURI	
DEPARTMENT OF CONSERVATION	E	NO Omnibus Reorganization Act of 1974	(prescribe and approve water pollution control measures)
DEPARTMENT OF NATURAL RESOURCES			
Division of Environmental Quality	E,I	MO Reorganization Act of 1974	Water Quality Management Planning Water Pollution Control Program (NPDES permits, administers duties of Clean Water Commission)
DEPARTMENT OF PUBLIC SAFETY	I	MO Reorganization Act of 1974	(assists in clean up and investigates water pollution accidents)
PUBLIC SERVICE COMMISSION	R,E	MO Statutes, Chapter 393	(prescribe standards for water purity, water inspection, sewer systems and treatment works)
		SOUTH DAKOTA	
DEPARTMENT OF ENVIRONMENTAL PROTECTION	E	SD Statutes	(administers Safe Drinking Water Act)
DEPARTMENT OF NATURAL RESOURCE DEVELOPMENT	S,R, E,I	SD Statutes	Water Quality Management Planning
Committee on Water Pollution			(establishes and enforces standards)
		WISCONSIN	
DEPARTMENT OF HEALTH AND SOCIAL SERVICES	R,E	WI Statutes, Chapter 15	(ensures the provision of sanitary water and sewers)
DEPARTMENT OF NATURAL RESOURCES			
Division of Environmental Standards	S,R, E,I	WI Statutes, Chapter 15	(planning, management and enforcement of water quality and NPDES permits)
Bureau of Water Supply			(reviews planning design construction, and operation of municipal water supply and sewage treatment system)
BOARD OF SOIL AND WATER CONSERVATION DISTRICTS	I		(guiding and coordinating local soil and water conservation districts)

[a]Scope of authority is defined as follows:
S= Statutory: research, collect information, coordinate, prepare plans
R= Regulatory: establish rules and regulations, issue permits
E= Enforcement: enforce laws and regulations
I= Implementation/Construction: administer funds, acquire land, construct and operate projects

Sources: Executive Office of the President, Office of Management and Budget, 1979 Catalog of Federal Domestic Assistance, May 1979.
Upper Mississippi River Basin Commission, FY 1978 Program Report of State and Federal Water and Related Land Resources Efforts, December 1978.
Upper Mississippi River Basin Commission, Upper Mississippi River Main Stem Level B Study, Technical Paper G: Legal and Institutional, August 1979. (draft)

for the installation of conservation measures recommended by the SCS. These programs are probably among the most instrumental efforts at improving regional water quality because of severity of agricultural nonpoint source pollution in the region. Limited funding in comparison to the size of the problem has been a major obstacle to widespread progress. The ASCS has also been assigned to administer the Rural Clean Water program which will provide technical and financial assistance for the adoption of Best Management Practices as recommended in the 208 Water Quality Management Planning Program.

Hazardous materials production, transportation, usage, and disposal are issues rapidly gaining national attention. The discovery of previously unreported and improperly constructed toxic materials disposal sites has caused

widespread concern because of the potential for air and water supply and land contamination. The Resources Conservation and Recovery Act (RCRA) is a federal law designed to provide an effective "cradle to grave" approach to the management of hazardous waste. Provisions of the law include: technical and financial assistance to state and local governments and interstate agencies for the development of solid waste management plans; training grants for solid waste disposal; prohibition of open dumping and conversion of existing facilities to facilities which do not pose a danger to the environment or to health; and the regulation of treatment, storage, transportation, and disposal of hazardous waste.

The U.S. Geological Survey (USGS) operates sediment stations within the region. Data are collected on sediment concentration and discharges in the rivers and streams. Water quality stations are operated by the USGS to determine the chemical and physical quality of rivers and streams for planning purposes.

Although the federal government has generally taken the lead in water quality management and planning it actively cooperates with state and local agencies. With federal assistance, the states are assigned to develop comprehensive solutions to prevent, reduce, and eliminate pollution. Approaches to water quality problems and the setting of standards varies considerably in each state.

The Illinois Environmental Protection Agency (IEPA) is the principal water quality planning and enforcement agency in the state. Through the Division of Water Pollution Control the state administers the requirements of the Clean Water Act and issues NPDES permits. The Division of Public Water Supply regulates the operation and sanitary quality of public water supplies and administers the Safe Drinking Water Act. Municipal wastewater treatment projects are prioritized by the IEPA and submitted for funding. In 1979-80, 953 projects are being considered for funding in the Illinois portion of the region.

The Indiana State Board of Health is responsible for the review and approval of the sanitary aspects of water supplies through the Division of Sanitary Engineering. Wastewater treatment plants and their operation are inspected through the Division of Water Pollution Control. The Environmental Management Board is responsible for protecting and enhancing water quality.

Water quality management, planning and enforcement responsibilities are divided among two primary agencies in Iowa. The Department of Environmental Quality (DEQ) sets water quality standards, prepares water quality management plans and programs, and determines the wastewater treatment project priority list of which 416 projects were eligible for funding in 1979-80. Facility grants, and management of the NPDES permit program are also the responsibilities of the DEQ. The Natural Resources Council enforces water quality regulations and prepares the state comprehensive water plan.

In Minnesota, the Pollution Control Agency (MPCA) has primary responsibility for the collection of water quality data, setting of standards, statewide water quality management planning, and administration of the NPDES permit program. The MPCA administers the Municipal Wastewater Treatment Project Priority List of which 187 projects were eligible for funding in 1979. Complementing these efforts, the Department of Natural Resources provides technical assistance in water quality. State cost-sharing funds for the application of soil and water conservation measures are administered by the Soil and Water Conservation Board.

The Missouri Department of Natural Resources, Division of Environmental Quality is responsible for water quality management planning, municipal wastewater treatment projects priority list, and NPDES permits. In 1979, 92 projects were eligible for funding. Responsibilities of the Clean Water Commission are to enforce water quality regulations and to conserve, protect, and improve the states public waters. The Department of Conservation prescribes and approves water pollution control measures.

In South Dakota, the Department of Natural Resource Development, Committee on Water Pollution, establishes and enforces standards for water quality and is responsible for preparing the statewide water quality management plan. The Department of Environmental Protection administers the Safe Drinking Water Act.

The Wisconsin Department of Natural Resources (Wis DNR) is responsible for the planning, management, and enforcement

of water quality rules and regulations. The Wis DNR also administers the municipal wastewater treatment project priority list of which 504 municipalities were eligible for funding in 1979.

Through the Wisconsin nonpoint source Water Pollution Abatement Program, the Galena River, Elk Creek, and Hay River watersheds projects are being developed to reduce agricultural nonpoint source pollution. Six Mile Creek and Pleasant Brand Creek projects are awaiting funding.

Alternative Solutions and Effects

Water quality in the Upper Mississippi Region is greatly influenced by man's activities. The control of point source pollution relies upon applying the correct technology to improve the quality of effluent while nonpoint source control is dependent upon the accurate identification of problems and the application of appropriate BMPs. The major water quality problems of the Upper Mississippi Region include the following:

1) Municipal and industrial discharges. Some wastewater treatment facilities in the region discharge inadequately treated effluent and these problems are intensified during low-flow periods.

2) Agricultural and urban runoff. Inadequate land management practices, especially on cropland, allows sediments containing nutrients and pesticides to enter the regions water courses.

3) Lake eutrophication. Nutrient enriched runoff and deposited organic sediments are causing accelerated eutrophication in many of the region's lakes.

4) Aquifer contamination. Seepage from solid waste disposal sites, and contaminated runoff entering the region's aquifers are causing contamination problems. These problems are especially evident in fractured limestone areas.

5) Hazardous materials. Toxicants such as PCBs, heavy metals, pesticides, and some industrial wastes are known to occur in the region's waters. Fish flesh samples indicate dangerous levels of some chemicals and fish consumptive warnings have been issued.

In order to meet the 1983 goals of the Clean Water Act accelerating implementation of advanced waste treatment measures on "water quality limited stream segments" may be necessary (Table II-6). Water quality limited segments are stream segments where it is known that water quality does not meet applicable standards and will not meet applicable water quality standards even if best practicable treatment technology for municipal discharges and best available technology for industrial discharges are attained or where standards will not be met due to projected development. Construction costs for completing and upgrading the proposed municipal wastewater treatment facilities projects in the region are estimated to be over $5 billion (Table II-7). More than 2200 Step 1, 2, and 3 projects are waiting to be funded through federal tax dollars and by state and local governmental assessments.

In some cases, streamflow augmentation may be the most cost-effective means to meet water quality standards. Flow augmentation involves the release of water from reservoirs to maintain the assimilative capacity of a stream. Federal agencies that plan reservoirs should consider storage for control of streamflow for water quality purposes. Flow augmentation cannot be used as a substitute for adequate treatment, which is best available treatment or best conventional treatment for industrial discharges, and good secondary treatment for municipalities. However, due to the environmental losses associated with reservoir construction, new reservoirs will need solid justification.

The public recognizes nonpoint source pollution as one of the most serious problems in the region. Significant increases in funding are needed to implement techniques to control the diverse and complex sources of nonpoint pollution in order to improve ambient water quality. Through statewide and areawide water quality management planning efforts, Best Management Practices (BMPs) have been developed to provide the most

TABLE II-6 ALTERNATIVE SOLUTIONS TO WATER QUALITY PROBLEMS AND NEEDS: ANALYSIS AND EVALUATION[a], UPPER MISSISSIPPI REGION

Alternative Solution (Problem Addressed)	Four Account Effects				Evaluation			Conclusion
	NED	EQ	RED	OSE	Planning Objective	Efficiency	Acceptability	
(1) Accelerate implementation of advanced waste treatment measures for municipal discharges and best available technology treatment for private and industrial dischargers (Municipal and industrial discharges)	- national cost - industrial output - service output - agricultural output	+ fish & wildlife habitat + surface water quality + groundwater quality	+ jobs - local cost + water supply - state cost	+ health & safety + recreation + aesthetics	EQ	Low	Medium	Conditionally Recommended
(2) Augment streamflows of water quality limited streams with control structures in lieu of advanced waste treatment (AWT) (Municipal and industrial discharges)	- national cost + industrial output	+ fish & wildlife habitat - natural areas + surface water quality + instream flows	+ jobs - local cost + water supply - state cost + flood damage reduction	+ health & safety + recreation + aesthetics	NED	Medium	Medium	Conditionally Recommended
(3) Accelerate implementation of Best Management Practices recommended under statewide and areawide water quality management plans (Municipal and industrial discharges; Lake eutrophication; Aquifer contamination)	- national cost + agricultural output + energy	+ fish & wildlife habitat + natural areas + surface water quality + groundwater quality + instream flows + erosion control + sediment control	+ economic stability - local cost - state cost	+ health & safety + recreation + aesthetics	EQ	High	Medium	Recommended
(4) Coordinate nonpoint pollution abatement programs of the USEPA and State Pollution Control Agencies with existing soil conservation programs of the U.S. Department of Agriculture and local soil and water conservation districts (Hazardous materials; Agricultural and urban runoff; Lake eutrophication; Aquifer contamination)	+ national cost + agricultural output	+ fish & wildlife habitat + surface water quality + erosion control + sediment control	+ economic stability - local cost - state cost	+ health & safety + recreation	NED,NS	Medium	Medium	Study
(5) Merge the statewide and areawide water quality management plans into an integrated regional water quality management plan for the region in order to minimize water quality conflicts and facilitate implementation of the plans (Agricultural and urban runoff; Lake eutrophication; Aquifer contamination; Hazardous materials)	- national cost	+ surface water quality + groundwater quality	- state cost	+ health & safety + recreation	EQ	Medium	Medium	Not Recommended
(6) Expand educational efforts by state water quality planning agencies to inform the public of low cost and easily applied means for reducing urban and rural nonpoint source pollution (Agricultural and urban runoff; Lake eutrophication)	xx	+ fish & wildlife habitat + surface water quality + sediment control	+ jobs + economic stability - local cost + water supply - state cost	+ real income + health & safety + recreation + aesthetics	EQ,NS	High	Medium	Recommended
(7) Accelerate research on the cause and effects of nonpoint source pollution and the relative on-site and off-site benefits and damages as related to suitable rates and timing of fertilizer and pesticide application (Agricultural and urban runoff; Lake eutrophication)	+ national cost + agricultural output + energy	+ fish & wildlife habitat + surface water quality + erosion control + sediment control	+ local cost + state cost	+ health & safety + education + recreation + aesthetics	NED,NS	High	High	Recommended
(8) Accelerate federal funding for lake restoration projects (Lake eutrophication)	- national cost + agricultural output + energy	+ fish & wildlife habitat + surface water quality	- state cost	+ health & safety + education + recreation + aesthetics	EQ	High	High	Recommended
(9) Accelerate research for the development of efficient urban street sweeping measures and construction site erosion control methods (Agricultural and urban runoff; Hazardous materials)	xx	+ fish & wildlife habitat + surface water quality + erosion control + sediment control	- local cost - state cost	+ health & safety	EQ,NS	High	Medium	Recommended
(10) Expand efforts to improve wastewater treatment plant operation, water recycling and land application. Support for research efforts such as irrigation and land disposal of wastewater and residual sludges, where soil conditions permit, could enhance the functional efficiency of waste water treatment systems (Municipal and industrial discharges)	- national cost + service output + industrial output + agricultural output + energy	+ fish & wildlife habitat	+ economic stability - local cost	+ real income	NED,NS	High	Medium	Recommended
(11) Adopt uniform state water quality standards for the Mississippi River and other waters of interstate significance (Municipal and industrial discharges; Hazardous materials)	xx	+ surface water + groundwater quality	- state cost	+ health and safety + recreation	EQ	Medium	Medium	Study

TABLE II-6. (Continued)

Alternative Solution (Problem Addressed)	Four Account Effects				Evaluation			Conclusion
	NEO	EQ	REO	OSE	Planning Objective	Efficiency	Acceptability	
(12) Monitor and regulate hazardous materials which are being produced, stored, or transported on or near the river (Hazardous materials)	- national cost - navigation	+ fish & wildlife habitat + surface water quality	- state cost	+ health & safety recreation + emergency preparation	EQ	Medium	High	Recommended
(13) No action	- national cost + service output + industrial output + commercial output - agricultural output	- fish & wildlife habitat - natural areas - surface water quality - groundwater quality - erosion control - sediment control	+ local cost + state cost - water supply	- health & safety - recreation - aesthetics	NED	Low	Low	Not Recommended

[a]Abbreviations in the Table: NEO (National Economic Development), EQ (Environmental Quality), REO (Regional Economic Development), OSE (Other Social Effects), NS (Nonstructural), XX (Not applicable)

For complete definition of Effects, Planning Objectives, Efficiency, Acceptablility, and Conclusions see Appendix E.

effective and practical means for minimizing sediments and polluted runoff from entering the region's waters (Table II-8). These measures attempt to optimize water quality benefits by keeping soils in place and reducing the transport of suspended and dissolved materials. Accelerated implementaion of BMPs on construction sites and agricultural lands could greatly reduce sediment, nutrients, and pesticide problems. BMPs used at dredged materials disposal sites and mined areas could significantly decrease the amount of contaminates and toxic materials in the water.

The voluntary nature of nonpoint source pollution control efforts along with inadequate funding has hindered the installation of BMPs. The major federal effort to reduce nonpoint pollution from agricultural areas is the Rural Clean Water Program. This program has been largely underfunded in the past year and funding may again be cut in FY 1982. Adequate funding--perhaps to the $400 million level--for this program will be necessary to accomplish widespread adoption of nonpoint source pollution controls.

Soil and water quality management is shared by the state pollution control agencies, the USEPA, and the USDA. Certain inefficiencies are inherent when program efforts overlap as they do with soil and water quality. By coordinating these management and planning programs a more thorough and comprehensive approach to the problem could be developed. The UMRBC could provide a forum for state and federal agency water quality management efforts in the region.

Water Quality Management Plans have been prepared for seven states and for nine designated areas in the Upper Mississippi Region under Section 208 of the Clean Water Act. These plans address point and nonpoint sources of pollution in the region and make recommendations to help solve water quality problems. These plans, however, have been developed with little coordination among the states. Merging these plans into an effective and coordinated regional water quality management plan for the Upper Mississippi Region may effectuate their implementation and minimize potential water quality conflicts.

Voluntary participation in nonpoint source pollution control efforts by the public could be one of the most efficient methods of improving regional water quality. Expanded educational efforts of state pollution control agencies could inform farm operators and developers of practical, effective, and low cost ways to reduce nonpoint pollution. However, because costs exceed the short-term benefits of erosion control, voluntary efforts will have to be complemented by financial incentives.

Major sources of nonpoint pollution are farm wastes and cropland runoff. However, the cause and effect relationship of fertilizer application and water pollution has not been clearly established. Strong evidence does suggest that elevated levels of nitrates and phosphorus occur under varying environmental conditions and management practices when fertilizers are used. Contributions that natural and manmade plant nutrients make to water quality are

TABLE II-7. 1978 WASTEWATER TREATMENT PLANT CONSTRUCTION NEEDS, UPPER MISSISSIPPI REGION

	Costs (million of 1978 $) by Need[a]						
	I	II	IIIA	IIIB	IVA	IVB	TOTAL
Upper Mississippi Region	684.5	2,431.5	282.2	22.7	570.5	1,102.0	5,093.4
Illinois Portion	72.1	1,227.9	158.6	4.0	159.7	336.1	1,958.4
Indiana Portion	4.3	36.9	.2	.3	19.2	14.0	74.9
Iowa Portion	141.8	289.5	74.0	.3	99.4	174.8	779.8
Minnesota Portion	10.5	648.8	21.0	12.1	136.0	247.3	1,075.7
Missouri Portion	377.3	.9	12.6	5.4	43.6	220.5	660.3
South Dakota Portion	.5	5.0	.4	-	.5	1.3	7.7
Wisconsin Portion	78.0	222.5	15.4	.6	112.1	108.0	536.6

[a] I (Plants requiring secondary treatment only)
II (Plants requiring advanced treatment levels)
IIIA (Infiltration/Inflow)
IIIB (Replacement and/or Rehabilitation)
IVA (New Collector Sewers)
IVB (New Interceptor Sewers)

Source: U.S. Environmental Protection Agency, 1978 Needs Survey, February 1979.

largely immeasurable. Proper timing of fertilizer and pesticide applications is important to minimize leaching and runoff. Intensive efforts should be made to inform plant operators, dealers, and distributors about damages associated with accidental leaks and spills, cleaning operations, and disposal problems. Research should be strengthened to obtain better information on soil treatment practices and effects as related to fertilizer and pesticide application.

Several inexpensive but important measures can reduce the amount of pesticide and fertilizer applications needed to maintain optimum production levels. One of the most effective measures to reduce field pests, including weeds, diseases, and insects is continual crop rotation. High grain commodity prices encourage farmers to continually plant the same crops year after year in order to maximize profits. This gives insects and disease that thrive on a particular crop the opportunity to establish themselves. When crops are rotated the nutrient and mineral cycling and addition process improves natural soil productivity. Over fertilizing and pesticide application can cause a buildup of chemicals which can be detrimental to production and water quality as well as causing unnecessary farm expenses. Expanded research in organic farming methods may be economically and environmentally beneficial.

Urban runoff carries numerous chemicals, nutrients, and oils and results in substantially degraded rivers, streams, and lakes. Maintenance of good water quality and fish and wildlife habitat is important for regional diversity. The USEPA Lake Restoration and Demonstration Grants program establishes the trophic level of state owned fresh-water lakes. Acceleration of this program will help evaluate the causes and effects of lake problems and the means to prevent or eliminate water pollution sources. Funding for this program in the region in 1980 was approximately $3 million.

Improved methods for street sweeping and deicing are needed as well as improved urban erosion control, runoff control, and oil recycling. New methods are in the experimental stage. A state and local experimental program coordinated with federal agencies could provide the necessary funding to make substantial progress in urban nonpoint source pollution control.

Improving the efficiency of wastewater recycling and application in municipalities, homes, and industries offers a unique opportunity for strides in controlling point source pollution. Recycling and waste application, perhaps on agricultural land, may afford a savings in water quantity but also in energy supplies. In addition to improv-

TABLE II-8. PRINCIPAL BEST MANAGEMENT PRACTICES

PRINCIPAL PRACTICES FOR CONTROLLING NUTRIENT LOSS	PRINCIPAL PRACTICES FOR CONTROLLING RUNOFF	PRINCIPAL PRACTICES FOR CONTROLLING PESTICIOE LOSS
General	General	Broadly Applicable
Eliminating excessive use of fertilizer	No-till planting	Using alternative pesticides
Leaching Control	Conservation tillage	Optimizing pesticide placement with respect to loss
Timing nitrogen application	Sod-based rotation	Crop rotation
Crop rotation	Winter cover crop	Pest-resistant crop varieties
Using animal wastes for fertilizer	Timing of field operations	Optimizing crop planting time
Plowing-under green legume crops	Plow-plant systems	Optimizing pesticide formulation
Controlling fertilizer release or transformation	Contouring	Mechanical pest control methods
Control of Nutrients in Runoff	Contour stripcropping	Reducing excessive pesticide use
Incorporating surface applications of fertilizer into the soil	Terraces	Optimizing time of day for pesticide application
Controlling surface applications of fertilizer	Grassed outlets	Applicable in Limited Cases
Using legumes in haylands and pastures	Contour listing	Optimizing date of pesticide application
Control of Nutrient Loss by Erosion	Change in land use	Using Integrated Pest Management programs
Timing fertilizer plow-down	Construction of ponds	Biological pest controls
	Tree planting	Reducing pesticide application rates
		Managing serial applications
		Planting between rows in minimum tillage

Source: U.S. Environmental Protection Agency, Water Quality Management Bulletin, Farmers and Clean Water Working Together, March 1980.

ing the water quality of the region and fish and wildlife habitat, these projects may provide economic benefits such as increased agricultural output. Research efforts to improve the efficiency of waste treatment operation should be supported. Where soil and effluent conditions permit, the land disposal of wastewater and residual sludges should be examined. When a consumptive waste treatment process is introduced such as land treatment or reuse for irrigation, the effluent returned to the stream is decreased. Low instream flows in some portions could be reduced to zero which would make this alternative undesirable.

Because each state in the region has set their own water quality standards a potential exists for serious interstate water quality conflicts. When the water quality standards of one state are set higher than the states upstream, water quality violations will occur. In order to minimize these conflicts and the legal problems that could arise, the UMRBC and the USEPA could provide a forum to coordinate policies for the water quality management planning agencies of the seven states. For example, materials dredged from the navigation channel are sometimes contaminated with potentially toxic substances. In addition to the hazards involved with the resuspension of these substances during dredging operations, problems have occurred with disposal practices. Because sediments may cause significant habitat problems, the USEPA and states could examine criteria for setting these standards to protect the riverine environment. The outcome of this effort would be uniform water quality standards for the Mississippi River and other waters of interstate significance in the region.

Because the cumulative effects of overlapping thermal plumes are largely unknown, the USEPA should consider requiring thermal discharges to file quarterly reports in identical formats. By doing this, a model may be developed which would help determine areas of greatest temperature difference and the physical and areal extent of the thermal problems. In addition, state and federal agencies should consider the need for additional pump-out facilities for boaters and the feasibility of establishing "no discharge areas." The UMRBC and states could jointly participate in such an effort.

Present water quality criteria for suspended sediments do not reflect the

need for preservation of aquatic life and habitat. Because sedimentation may be a greater threat to aquatic habitat than diminished primary productivity, criteria is need which would protect habitat as well as the photosynthetic process. In addition, dredging related water quality criteria, which would protect aquatic life and habitat, are needed.

The continual development and enforcement of hazardous materials regulations by the U.S. Coast Guard is imperative as a long-term environmental safeguard. While the protection of hazardous materials stored on the floodplain may provide assurance against floodwaters, transportation accidents are a continual threat. Additional safety precautions are needed to prevent such disasters. Industrial waste pretreatment and recovery efforts could minimize the possiblity of waste disposal accidents. The possibility of rail accidents involving hazardous materials near the river is a significant environmental threat which the Federal Railroad Administration (FRA) should examine. Additional safety measures should be taken by the FRA to prevent such an accident.

Conclusion

Without the implementation of any water quality alternative (no action), new programs will not be initiated and funding for current programs would remain at the present level. Water quality would improve somewhat during low-flow periods as wastewater treatment facilities are completed. Problems associated with nonpoint source pollution, however, will continue and worsen as more and more sediments are allowed to erode into water courses. Depleted soils will diminish agricultural production if no further action is taken. Recreation, regional aesthetics, health and safety, and fish and wildlife habitat will also be degraded.

Although merging of statewide and areawide water quality management plans could provide a comprehensive and coordinated approach to solving water quality problems affecting the Upper Mississippi Region, the benefits would probably not justify the cost of such an effort.

Accelerating the implementation of advanced waste treatment (AWT) measures to meet the 1983 goals of the Clean Water Act is an extremely costly and publicly unacceptable alternative to improving water quality. Over $5 billion is needed to complete wastewater treatment facilities in the region. Rather than accelerate AWT, it is recommended that full authorization funding be provided to the wastewater treatment plants program to meet the goals by 1990. Expanded stream flow augmentation should be examined for its potential and applied at existing and planned reservoirs when conditions are appropriate.

Best Management Practices recommended in the statewide and areawide water quality management plans are integral elements of nonpoint source pollution control and should be accelerated. Programs such as Rural Clean Water and statewide nonpoint source pollution control, are expensive yet necessary and publicly acceptable components for pollution abatement efforts. The Lake Restoration Program should be accelerated and provisions should be altered to permit upland treatment in the watershed of project lakes. The coordination of USEPA, USDA, and state pollution control programs should be studied as a means to improve governmental and administrative efficiency. The information efforts of state agencies should be expanded as a means to get citizen cooperation in pollution control efforts.

Expanded research should be carried out to better define the relationships between fertilizer and pesticide application and nonpoint source pollution problems. In addition research to improve street sweeping methods is needed to enhance the quality of urban runoff.

Incentives should be expanded to encourage the development of new technologies in wastewater treatment and sewage sludge disposal. Sewage sludge application, irrigation with wastewater, and wastewater recycling are potential resources which need greater attention and consideration. This contribution to improved water use efficiency and cropland production should be promoted provided these sludges prove to be environmentally safe for application.

Water quality standards consistency is necessary to prevent potential interstate conflicts. An evaluation of water quality standards for suspended and deposited sediments should be made to protect aquatic life and habitat and to develop criteria for the disposal of dredged

materials. Thermal monitoring reports should be submitted in a consistent format in order to provide a tool for evaluation of the river ecosystem.

An analysis of hazardous materials which are produced, transported, or stored on or near the riverine environment will be a significant attempt to avert environmental catastrophies associated with contaminants. The monitoring and regulation of these materials and their recovery in industry is needed as an environmental safeguard.

EROSION AND SEDIMENTATION

Current Conditions and Problems

Soil erosion and sedimentation are the most severe and enduring water related land resource problems occurring throughout the Upper Mississippi Region. All land uses and soil types are subject to some degree of erosion. However, because of the predominance of agriculture, and the nature of the activity, the greatest amount of soil loss occurs on cropland. Soil losses caused by sheet and rill erosion on cropland vary considerably but average about 6.43 tons per acre per year.[17] For the region as a whole average annual erosion rates range from less than 1 ton per acre on well protected or permanently covered soils to more than 40 or 50 tons per acre per year on construction sites which are the most susceptible areas. Nationally, erosion averages 4.77 tons per acre per year.

[17]U.S. Department of Agriculture, Soil and Water Resources Conservation Act: 1980 Appraisal Part II, 1980. (review draft)

Erosion

Erosion is a natural process but is often accelerated by man's activities. The types of erosion occurring in the region include sheet and rill, gully, streambank and channel, wind, roadside, shoreline, and construction site. The continuous use of agricultural land, especially cropland, accelerates the erosion process making cropland erosion by far the most severe form of erosion (Table II-9, Figure II-4). Using conventional tillage, row crops such as corn and soybeans leave large areas of ground uncovered throughout the growing season and the soil is subsequently susceptible to erosion. Construction site erosion is extremely severe because of the complete exposure of the soils during the development period. However, long-term and continuous erosion after development is seldom an enduring problem.

Sheet erosion is an insidious process which removes a fairly uniform layer of soil from the land surface by runoff water or wind. In its advanced stages small rills or gullies are formed which

TABLE II-9. ESTIMATE OF CURRENT MAJOR LAND USE AND GROSS SOIL EROSION BY SUBREGION, UPPER MISSISSIPPI REGION

	Cropland[a]			Pastureland			Forestland			All Other Land	Total Land	
Subregion	Acres (1000)	Ton/acre per year[b]	Gross Erosion (1000 Tons)	Acres (1000)	Ton/acre per year[b]	Gross Erosion (1000 Tons)	Acres (1000)	Ton/acre per year[b]	Gross Erosion (1000 Tons)	Acres (1000)	Acres (1000)	Gross Erosion[c] (1000 Tons)
Mississippi Headwaters	4,372	2.33	10,187	990	.36	356	4,475	.10	448	3,417	13,254	10,991
Minnesota River	8,000	2.50	20,000	742	.27	200	188	1.69	318	1,174	10,104	20,518
Saint Croix	600	2.56	1,536	260	1.21	315	1,511	.23	348	518	2,889	2,199
Black-Root	3,450	5.63	19,424	857	2.63	2,254	1,776	4.04	7,175	923	7,006	28,853
Chippewa	1,425	2.57	3,662	390	1.80	702	2,600	.37	962	716	5,131	5,326
Maquoketa-Plum	2,998	8.15	24,434	700	2.99	2,093	600	5.30	3,180	399	4,697	29,707
Wisconsin	2,100	3.20	6,720	830	1.63	1,353	3,000	2.85	8,550	1,147	7,077	16,623
Iowa-Skunk-Wapsipinicon	11,900	9.37	111,503	1,417	2.59	3,670	652	2.90	1,891	1,678	15,647	117,064
Rock	4,264	5.86	24,987	580	1.88	1,090	420	1.34	563	842	6,106	26,640
Des Moines	7,200	6.75	48,600	1,100	2.77	3,047	385	2.53	974	1,087	9,772	52,621
Salt-Sny	3,500	13.53	47,355	1,200	7.54	9,048	800	6.83	5,464	318	5,818	61,867
Upper Illinois	3,700	4.94	18,278	215	1.38	297	250	.31	78	1,722	5,887	18,653
Lower Illinois	8,400	6.81	57,204	976	6.39	6,237	800	2.98	2,384	846	11,022	65,825
Kaskaskia-Meramec	5,500	7.16	39,380	1,600	3.74	5,984	3,600	2.33	8,388	1,154	11,854	53,752
Region Total	67,409	6.43	433,270	11,857	3.09	36,646	21,057	1.93	40,723	15,941	116,264	510,639

[a]Includes rotation pasture

[b]Soil erosion cannot be accurately estimated and is not significant beyond the nearest whole number. Fractions are used to facilitate computations.

[c]Gross erosion totals do not include all other land.

Sources: U.S. Department of Agriculture, Soil and Water Resources Conservation Act: 1980 Appraisal Part II, 1980.(review draft)
U.S. Department of Agriculture, Soil Conservation Service, 1967 Conservation Needs Inventory.
U.S. Department of Commerce, Bureau of the Census, Census of Agriculture, 1974.

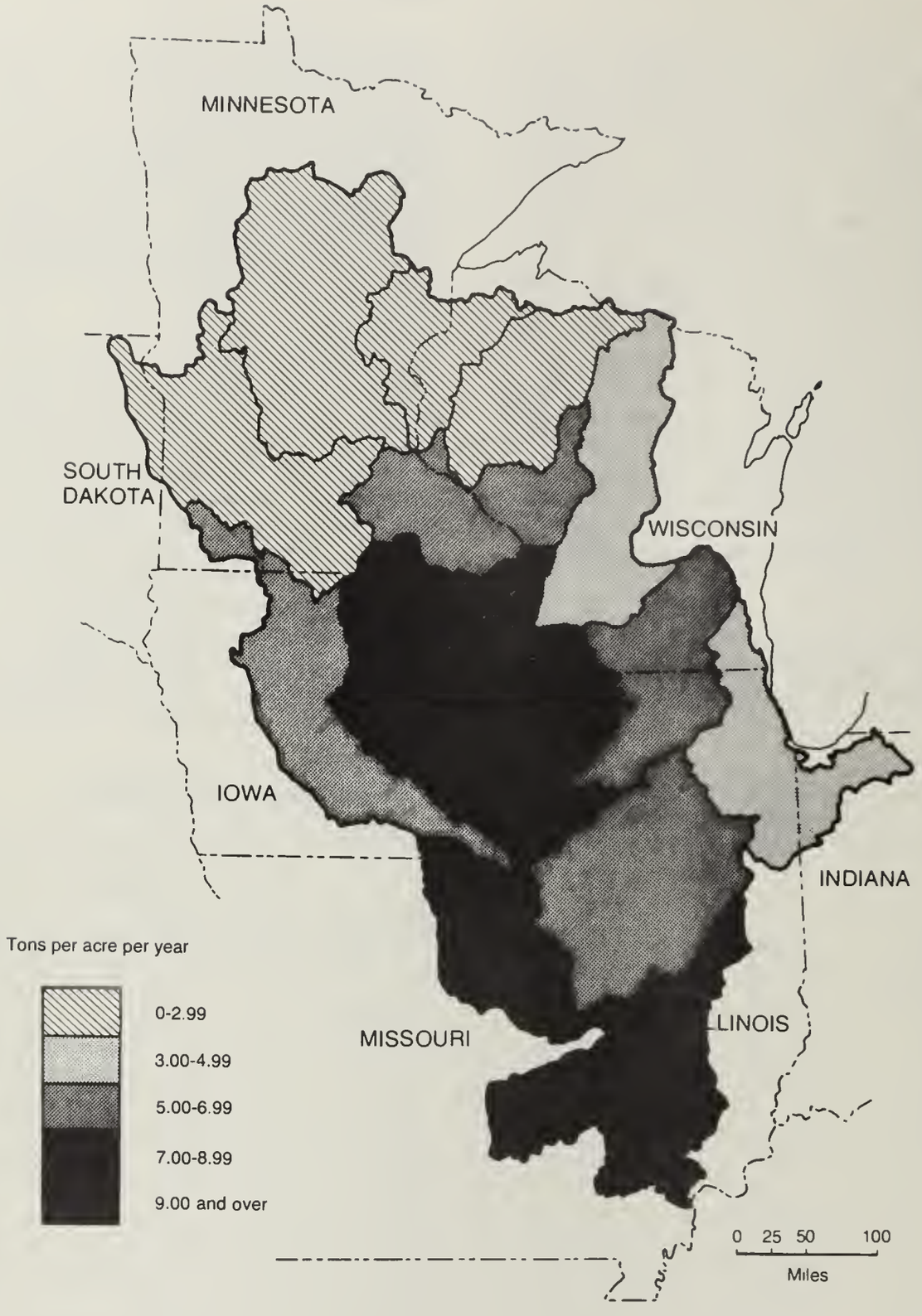

FIGURE II-4. SOIL EROSION FROM CROPLAND BY SUBREGION, UPPER MISSISSIPPI REGION

Source: U.S. Department of Agriculture, Soil Conservation Service, *1977 National Resources Inventory*, 1979. (unpublished data)

can usually be smoothed out by normal plowing. Severe or very severe sheet erosion is occurring in large areas in the Maquoketa-Plum, the Iowa-Skunk-Wapsipinicon, Des Moines, Rock, Kaskaskia-Meramec, Salt-Sny, and in the Lower Illinois river basins. Areas of gently to steeply sloping lands are most seriously affected by sheet erosion because water rushing down a hill increases its erosive capacity.

Throughout much of the region blufflands are farmed or pastured. The steep slopes of blufflands are highly erosive unless well protected. Although pasturing causes less erosion than cropping, livestock can accelerate erosion by damaging groundcover. Bluffs along the Mississippi, Maquoketa-Plum, Salt-Sny, Iowa-Skunk-Wapsipinicon, and Kaskaskia-Meramec rivers are eroding at rates of greater than 15 tons per acre per year. Blufflands along the Upper and Lower Illinois River are also eroding severely at 8 to 10 tons per acre per year.

Missouri has the greatest average annual cropland soil loss at 11.38 tons per acre while Minnesota has the least average annual soil loss at 2.31 tons per acre. The average annual soil loss in tons per acre for the other states include: 6.72 for Illinois, 9.91 for Iowa, and 3.6 for Wisconsin. Erosion on pastureland is substantially less than on cropland. Pastureland erosion averages 3.09 tons per acre and is most severe in the southern portions of Illinois and Missouri (Figure II-5). Forestland erosion averages 1.93 tons per acre and is most severe in northeastern Iowa and northeastern Missouri.[18]

Land use in the region is principally agricultural. Of the total 119 million acres of land and water, 100 million

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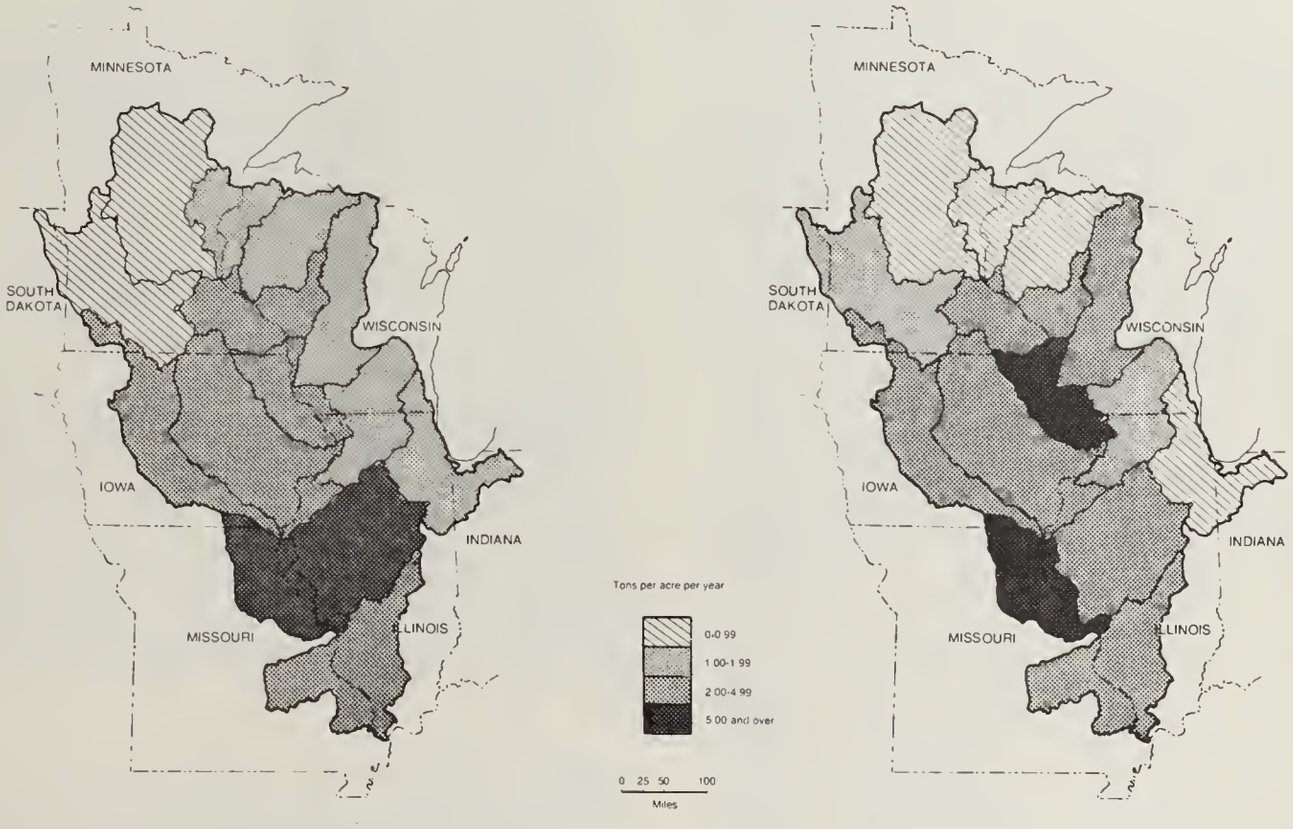
[18]U.S. Department of Agriculture, op. cit., footnote 16.



Soil Erosion From Pastureland

Soil Erosion From Forestland

FIGURE II-5. SOIL EROSION FROM PASTURELAND AND FORESTLAND BY SUBREGION, UPPER MISSISSIPPI REGION

Source: U.S. Department of Agriculture, Soil Conservation Service, *1977 National Resources Inventory,* 1979. (unpublished data)

acres are in agricultural and forestland uses, 16 million acres in non-agricultural uses and nearly 3 million acres are occupied by water. The principal agricultural uses are cropland with 67 million acres and forestland with 21 million acres. The principal non-agricultural use is urban land with nearly 5 million acres.

More than 25 percent or 25 million acres of the total crop, pasture, and forestland in the region have erosion rates that exceed 5 tons per acre annually (Table II-10). Nearly 8 million acres have erosion rates that annually exceed 14 tons per acre. Land treatment is generally needed when erosion rates exceed 4 to 5 tons per acre per year. Nationally, 19 percent of the crop, pasture, and forestland have erosion rates greater than 5 tons per acre per year. This region's cropland is considered among the nation's most productive and at the same time is eroding at a substantially greater rate than the national average.

Land use in the region relates generally to land capability.[19] The land capability classification system groups soils on the basis of their ability to produce common cultivated crops and pasture plants without deterioration. Lands in capability classes 1, 2, and 3 are used mainly for cropland. Lands in classes 4, 5, 6, and 7 are used mainly for pasture, range, and forest. Erosion occurring on Class 3 land is the most severe (Table II-11).

Severe soil erosion is not unique to the Upper Mississippi Region. In 1977, the USDA, Soil Conservation Service (SCS) concluded that nationally more than 2 billion tons of topsoil were washed away from cropland and an additional 3 billion tons from crop and rangeland were lost to wind erosion. When soil erosion losses average 10 tons per acre per year, as much as a half inch of topsoil is lost

TABLE II-10. SHEET, RILL, AND WIND EROSION ON NONFEDERAL AGRICULTURAL LAND, UPPER MISSISSIPPI REGION

	Tons/Acre per Year			
	Less than 5	5-13.9	14+	Total
	(1000 acres)			
Cropland	45,503	15,120	6,786	67,409
Pastureland	9,986	1,257	614	11,857
Forestland	19,584	903	571	21,057
Total	75,073	17,279	7,971	100,323
	(Percent)			
Cropland	67.5	22.4	10.1	100.0
Pastureland	84.2	10.6	5.2	100.0
Forestland	93.0	4.3	2.7	100.0
Total	74.8	17.2	8.0	100.0
U.S. Percent	81.2	12.5	6.3	100.0

[a]Forestland data includes federal forestland

Source: U.S. Department of Agriculture, Soil and Water Resources Conservation Act: 1980 Appraisal Part II, 1980. (review draft)

TABLE II-11. SOIL LOSS BY LAND CLASS-SUBCLASS IN 1977 UPPER MISSISSIPPI REGION

Land Class/Subclass	Cropland	Pasture	Forest	Total
	(percent)			
1	6.5	0.4	0.1	5.3
2E	25.6	4.0	1.4	21.9
2S	1.2	0.1	*	1.0
2W	10.8	2.2	0.6	9.3
3E	32.3	19.2	2.2	28.7
3S	0.5	1.1	0.2	0.5
3W	1.9	0.6	0.1	1.7
4E	10.4	21.1	11.2	11.2
4S	0.6	0.7	3.7	0.9
4W	0.2	0.1	*	0.3
5W	*	0.1	*	*
6E	7.8	30.9	21.4	10.7
6S	0.2	0.3	2.0	0.3
6W	*	*	*	*
7E	1.3	15.5	43.2	6.0
7S	0.4	3.4	13.6	1.7
7W	-	*	*	*
8E	-	0.1	*	*
8S	-	*	-	*
8W	-	*	*	*

[a]Capability classes, the broadest groups, are designated as classes 1 through 8. The numerals indicate progressively greater limitations and narrower choices for practical use. The classes are defined as follows:
Class 1 soils have few limitations that restrict their use.
Class 2 soils have moderate limitations that reduce the choice of plants.
Class 3 soils have severe limitations that reduce the choice of plants.
Class 4 soils have very severe limitations that reduce the choice of plants.
Class 5 soils are not likely to erode but have other limitations, impractical to remove, that limit their use.
Class 6 soils have severe limitations that make them generally unsuitable for cultivation.
Class 7 soils have very severe limitations that make them unsuitable for cultivation.
Class 8 soils and landforms have limitations that nearly preclude their use for commercial crop production.

Capability subclasses are soil groups within one class; they are designated by adding a small letter, "e," "w," "s," or "c," to the class numeral, for example, 2e. The letter "e" shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; "w" shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); "s" shows that the soil is limited mainly because it is shallow, droughty, or stony; and "c," used in only some parts of the United States, shows that the chief limitation is climate that is too cold or too dry.

*Less than .1 percent
-None

Source: U.S. Department of Agriculture, Soil and Water Resources Conservation Act: 1980 Appraisal Part II, 1980. (review draft)

[19]The quality of soil resources for agricultural use is commonly expressed as land capability classes and subclasses, which show, in a general way, the suitability of soils for most kinds of field crops. Soils are grouped according to their limitations when they are used for field crops, the risk of damage when they are used, and the way they respond to treatment.

every 7 years.[20] The regional level of 6.43 tons per acre per year incurs an average loss of one half inch of topsoil every 11 years. As much as 5 inches of topsoil could be lost in the next 100 years at this rate. Because only the top 6 to 8 inches of soil are usually considered productive for most small grains this is a particularly severe loss. The subsoil can be made productive only through time and very expensive and energy intensive processes. However, when subsoils are composed of clays or rock, little can be done to renew their productivity.

Soil productivity is nearly always reduced by erosion and where topsoils are thinnest the effects are usually greatest. The costs of producing agricultural commodities increases with the rate of erosion. A loss of 1 inch of topsoil - 150 tons - may reduce corn yields by 3 bushels per acre per year. Assuming corn prices of $2 per bushel, the cummulative loss to the farmer over a 50 year period is $750. Topsoil is then worth $1.00 per ton based solely on the soils contribution to crop production.[21]

Under normal weathering and good farming conditions, past harvest residue and the remaining organic matter, in addition to the mixture of favorable subsoils, will replace 4 to 5 tons of topsoil per acre per year. Soil losses greater than 4 to 5 tons per acre depletes the soil resource and its fertility. When topsoils are thinner as in northeast Iowa and southeast Minnesota, tolerable soil losses may be less than one ton per acre per year. Soil once lost by wind and water is not economically recoverable.

Government support and pricing policies have been detrimental to soil conservation. High commodity prices encourage fencerow to fencerow planting at the general cost of soil conservation. The problem of soil conservation during periods of low prices stems from government set-aside programs which do not allow land held out of production for conservation purposes to be counted as part of the set-aside acreage.

Currently soil conservation incentives are inadequate for farmers to afford the installation of erosion controlling structures. Although long-term benefits of conservation include improved production and water quality, short-term gains cannot economically justify expensive measures such as terraces and diversions. In 1978, Congress appropriated $190 million nationally to subsidize the farmers' soil conservation costs. The same amount of money has been appropriated in each of the last 10 years. Because of inflation, only two-thirds of the work can be completed as was in 1969. Terracing and gully control can cost up to $400 per acre. This large expense makes a subsidy necessary in order to accomplish the widespread adoption of conservation practices.

Sedimentation

Soil erosion and sedimentation are functions of complex variables including climate, geology, soil composition, topography, vegetative cover, land use and management, and the activities of man and animals occurring on the land. Most of the products of erosion move only a few feet from where they were eroded. Eroded soil particles may be deposited and re-eroded many times before finally entering a watercourse. A small portion will reach a channel where it may be carried by the current for long distances before deposition. Some of the finer sediments may be carried to the ocean, or deposited in lakes or backwaters. The sediment delivery system is related to channel density, topography, stream side land use, and entrapment areas. High sediment yields can be expected in areas with abundant channels and gullies, steep hilly topography, inadequate streamside buffer zones, and an absence of lakes and swamps. Conversely, low sediment yields can be expected from areas with few channels, flat topography, adequate buffer zones, and an abundance of swamps and lakes.

Annual sediment yields in streams and rivers throughout the region range from 10 to over 6000 tons per square mile

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[20]Soil losses were computed using an average weight of 80 pounds of soil per cubic foot.

[21]U.S. Department of Agriculture, Soil and Water Resources Conservation Act, 1980 Appraisal Part II, 1980. (review draft)

(Figure II-6). Sediment loads in the Mississippi River significantly increase below the confluence of the Missouri River. Resulting damages from sediments adversely affect the quality of surface water and causes shoaling in navigation channels and excessive deposition in lakes, rivers, streams, and backwater areas. Additional damages occur to land, open ditches, and roads. Fish and wildlife habitat and recreational areas such as beaches and backwaters are severely affected by the fine sediments and the transported residuals, such as phosphorous, pesticides, and heavy metals. The accumulation of fine sediments in backwaters, low-flow areas, and isolated side channels has caused significant loss of productive aquatic habitat since the damming of the Mississippi River. If allowed to continue at the present rates, sedimentation may convert much of this habitat acreage into semiaquatic marshland within the next century.[22]

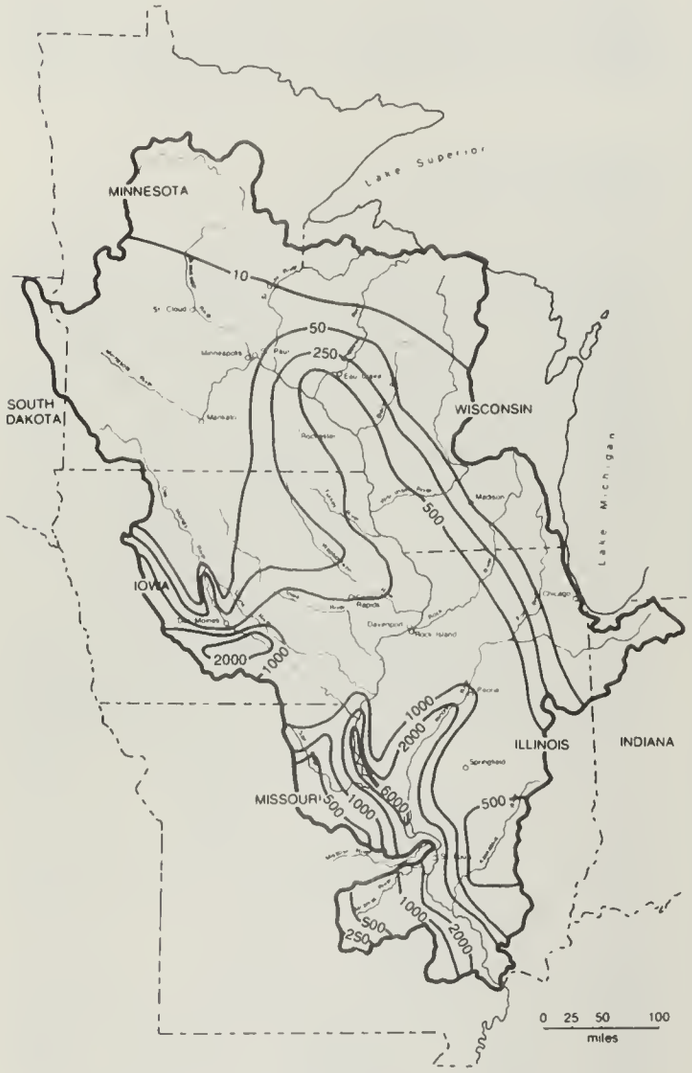

FIGURE II-6. ANNUAL SEDIMENT YIELD*, UPPER MISSISSIPPI REGION

*Tons per square mile for a 100 square mile drainage area.

Source: UMRCBS Coordinating Committee, *Upper Mississippi River Comprehensive Basin Study*, (Vol. III), 1970.

The deposition of infertile sands and gravels on agricultural and natural areas can cause severe productivity losses in addition to destroying plants when materials are deposited on growing foilage. Excessively turbid water normally requires treatment for public and industrial uses.

Sediment loads in rivers and streams is determined by velocity, volume, water temperature, and erosive character of the bed and walls of the channel. At high water, the stream may erode its banks and bed and at low water. The same stream may deposit alluvium. When a stream meets a barrier such as a lock or dam, it slows down and drops the sediment load. Subsequently the water-carrying capacity of the channels is reduced and flooding may be experienced. Streambank erosion on tributaries is the leading contributor of coarse sand sediments which enter the river system. Accumulation of these sediments, which are primarily confined to the main channel bed, requires dredging for the 9-foot navigation channel and the placement of dredged material may cause serious damage to biological activity.[23]

In the portion of the Mississippi River below lock and dam 27, sediment loading and deposition requires dredging to be continuous in order to maintain navigation channel depth. Part of the flooding problem on the Mississippi River is also due to deposition in the bed which raises the level of the bed and the water surface relative to the surrounding floodplain and levees. In parts of the Lower Mississippi Basin, the river's normal water surface is above the floodplain, held in place only by the levees. Therefore, controlling erosion would reduce sediment loading and deposition, and would then lengthen the life expectancy of navigation and flood

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[22]Great River Environment Action Team, GREAT I Report, Channel Maintenance, 1979.

[23]Great River Environmental Action Team, op. cit., footnote 20.

control projects.

The St. Paul, Chicago, Rock Island and St. Louis Districts of the U.S. Army Corps of Engineers maintains the navigation channels of the Mississippi, Illinois, Minnesota, St. Croix, Black, and Kaskaskia rivers. Sediments are dredged from the entire Mississippi River channel at an annual average rate of about 8 million cubic yards. However, the greatest deposition of sediments occurs below St. Louis where 4.2 million cubic yards are dredged each year. In the Illinois River, sediments are dredged at an annual average rate of about 1.2 million cubic yards. Dredging requirements needed to maintain navigation vary considerably by year and location site.

Anticipated Problems

The region's most serious soil losses in the future will continue to be from cropland. Assuming current levels of funding and crop production practices, soil will continue to erode at an average rate of over 6 tons per acre per year. Nearly 470 million tons of soil will be removed annually from 77 million acres used in production. In order to maintain the 1977 level of production, approximately $1.7 billion worth of fertilizers and about $563 million worth of pesticides will be needed each year.[24] Extensive use of farm chemicals will continue to degrade the region's waters through agricultural nonpoint source pollution. However the most serious long-term effect of the erosion problem will be the reduced capacity for food and fiber production. If the existing erosion level continues for the next 50 to 100 years much of the region's productive agricultural acreage could be depleted because of the loss of topsoil.

A variety of complex and interrelated farm pressures could dramatically increase the problem without urgent and immediate action. Development pressures from urban areas, as well as current production costs, demands, and methods could intensify already serious soil losses. When more marginal land is put into production soil erosion usually accelerates. Soil erosion potential is severe or very severe in many portions of the region (Figure II-7). The erosion potential of an area shows in a general way where the greatest potential for soil loss occurs and where there is the greatest need for soil conservation practices. Severe or very severe categories indicate a potential for soil losses from 8 to greater than 10 tons per acre per year.

Throughout the nation, the funds being spent to conserve the soil resource is incommensurate with the magnitude of the erosion and sedimentation problem. Unless drastic increases in funding are made available to the farm producers there could be disasterous national and international results such as diminished production capabilities and severe food shortages.

The primary objective of any erosion and sediment control program should be to retain the soil resource in its place of origin. Some past actions have stressed reacting to symptoms of the major underlying problem. For example, some farm producers continually treat eroded soils with expensive fertilizers to sustain yields. A more prudent and long-term approach to sustained production is to manage the land using conservation tillage systems that treat the land to retain the topsoil.

If widely adopted on agricultural land, conservation measures should substantially reduce erosion and sediment problems and reduce nonpoint pollution. Conservation measures on cropland can range from inexpensive and energy conserving chisel plowing to expensive measures such as terracing. Unless funding is made available to the farm producers for installation of conservation measures erosion problems will continue and worsen. Where steep hillsides are being farmed, it may be necessary to remove the land from production entirely to avoid total loss of topsoil and to improve water quality.

A major problem with erosion and sedimentation control is informing the farm producers and the general public to understand its magnitude and seriousness. While many effective and inexpensive erosion control measures could be easily adopted, these groups generally lack the knowledge or desire to rectify erosion and sediment problems. This is largely because few short-term benefits from con-

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[24]These are gross estimates from the Soil and Water Resources Conservation Act: 1980 Appraisal Part II, 1980. (review draft)

servation are received by farm producers and landowners.

To a large degree, inflated prices for land and retail goods, while crop prices remain low, cause depressed conditions for farmers, and dictates farming practices. The short-term economic benefits of intensive and extensive tillage (to raise the biggest crop possible from the land) influences the farmer's decisions.

Although the short-term effects of erosion are not as severe as flooding, the long-term effects can have far more devastating consequences. Alerting the farm producers and the public to the causes and solutions to erosion and sediment problems and the major benefits resulting from the halting of these processes, in addition to providing the necessary financial incentives, should be a primary goal of any erosion control program.

Depleted soils, resulting from erosion and overproduction, require increasingly more fertilizers to produce profitable yields. This intensive fertilization greatly increases production costs and may reduce water quality. Without a de-emphasis on fertilization and an increased emphasis on soil conservation production problems will increase. The objective of erosion control is to retain the soil in its place. The primary means to accomplish this is to reduce runoff velocity and total water volume from the land. In the region water erosion is the largest transporter of soil and by encouraging or improving infiltration and slowing the speed of runoff water, a greater percentage of soil can be saved. Increased infiltration has associated benefits of retained soil moisture for crop production, enhanced groundwater supplies, and substantially improved water quality. Immediate treatment of critically eroding land and the installation and maintenance of long-term conservation measures are necessary.

Coupled with decreased funds, inflation, and a worsening problem, increasingly less is being accomplished in the treatment of eroding land. The availability of funds and the accelerated application of conservation measures will largely determine the magnitude of future problems.

Urban land conversion and land speculation could have a deleterious effect on land use patterns and availability. Nationally, farmland is being converted to urban development at a rate of 3 to 5 million acres each year. Erosion in urban areas associated with construction accelerates as a result of these activities, but more importantly, converting agricultural land to urban uses will require converting more marginal and potentially erosive agricultural land for cropping purposes in order to sustain the regional production level. Marginal land will be more heavily fertilized and the application of land treatment measures are far more expensive because of the hilly nature of much of the land. As a result of urban pressures, reductions in fertile cropland could lead to significant future rises in production costs and food prices and a decline in export potential.

Many farmers do not practice conservation because of absentee ownerships of farmland. Farmers who till rented land may have no vested interest in conserving soil since their investment in the land is not returned to them. The owner of this land may be reluctant to pay for conservation measures if the land will be sold or developed.[25]

With an apparent national trend toward increasingly larger farms, new production methods can adversely affect soil erosion. Massive new equipment needs large fields for efficient operation. Fencerows, windbreaks, contours, terraces, and diversions continue to be removed in order to maneuver larger equipment. The progress gained on erosion problems is lessened with the removal of these measures. For optimal use of this expensive machinery many operators are resorting to untimely commercial work such as fall plowing. This practice leaves the soil uncovered through the winter and early spring and more prone to wind erosion.

Center pivot irrigation systems are now widely used. These systems operate most efficiently when allowed to swing a full circle in a quarter section of land. Because features such as windbreaks and terraces serve to obstruct the equipment many farmers are removing these conservation measures and leveling their fields. These systems work best on

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[25]Gerald R. Calhoun, "Project Clearwater," Water Spectrum, Winter 1979.

FIGURE II-7. SOIL EROSION POTENTIAL*, UPPER MISSISSIPPI REGION

*Information not available for South Dakota.
In Minnesota and Wisconsin "Severe" includes wind erosion potential.

Sources: adapted from Illinois Environmental Protection Agency, *Water Quality Management Plan,* Vol. III, *General Soil Loss Ranges for Illinois*, 1979. (map)
adapted from Indiana Department of Natural Resources, *Soil Erosion Potential in Indiana,* 1980. (map)
adapted from Iowa Department of Soil Conservation, *Erosion Sensitivity Map by Watershed,* 1978. (map)
adapted from Missouri Department of Natural Resources, *Missouri Water Quality Management Plan,* 1979. (map)
adapted from U.S. Department of Agriculture, Soil Conservation Service, *Soil Erosion Potential in Minnesota,* 1978. (map)
adapted from U.S. Department of Agriculture, Soil Conservation Service, *Soil Erosion Potential in Wisconsin,* 1979. (map)

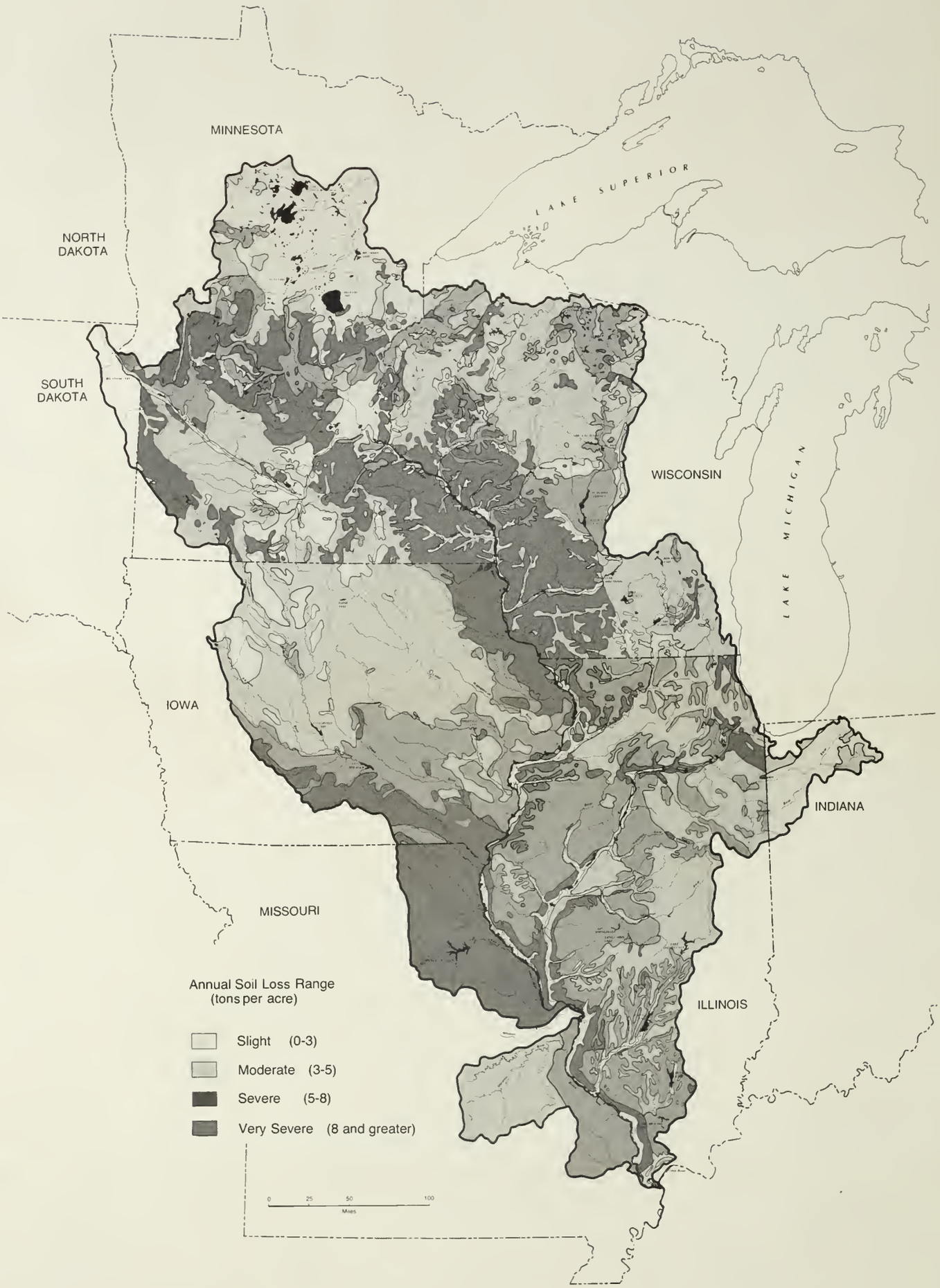

FIGURE II-7. SOIL EROSION POTENTIAL*, UPPER MISSISSIPPI REGION

*Information not available for South Dakota. In Minnesota and Wisconsin "Severe" includes wind erosion potential.

Sources: adapted from Illinois Environmental Protection Agency, *Water Quality Management Plan*, Vol. III, *General Soil Loss Ranges for Illinois*, 1979. (map)
adapted from Indiana Department of Natural Resources. *Soil Erosion Potential in Indiana*, 1980. (map)
adapted from Iowa Department of Soil Conservation, *Erosion Sensitivity Map by Watershed*, 1978. (map)
adapted from Missouri Department of Natural Resources, *Missouri Water Quality Management Plan*, 1979. (map)
adapted from U.S. Department of Agriculture, Soil Conservation Service, *Soil Erosion Potential in Minnesota*, 1978. (map)
adapted from U.S. Department of Agriculture, Soil Conservation Service, *Soil Erosion Potential in Wisconsin*, 1979. (map)

slopes less than 5 or 6 percent so farmers are leveling their land and sometimes indiscriminately destroying topsoil.[26] As center pivot irrigation systems gain in popularity the occurrence of soil erosion problems will become more frequent.

Governmental Authority, Responsibility, and Policy

Farming has been practiced throughout most of the Upper Mississippi Region for less than 100 years. In that short period of time, through natural forces combined with neglect, overuse, complacency, and ignorance, more than half of the original topsoil has been lost to water and wind erosion.[27] When the sod was originally turned there existed an average of 14 to 16 inches of productive topsoil. Today, an average of only 6 to 8 inches of that soil remain. Nature needs 250 to 1000 years to build one inch of topsoil.

Not until the "Dust Bowl" years of the 1930s, did the national significance of erosion become apparent. Devastating dust storms of that period resulted from a long drought following a period in which indiscriminate farming practices were used. Sheet, gully, and rill erosion severely depleted the soil resource and its productive capability. During that period tremendous soil losses were incurred. However, soil loss today surpasses the Dust Bowl years, sometimes occuring at twice the tolerable rate or more. In the mid-1930s, recognizing the urgency of the matter, the federal government took action. With the passage of the Soil Conservation and Domestic Allotment Act of 1935, the U.S. Department of Agriculture, through the Soil Conservation Service (SCS), was authorized to plan and carry out a national soil and water conservation program. The provisions of the program called for technical advice, leadership, and direction needed to develop, protect, and manage the nation's soil, water, and related resources. The Act was aimed at assuring that erosion of this magnitude would not reoccur (Table II-12).

Through the Soil and Water Conservation Program, the SCS today provides technical and program support to the region's 284 soil and water conservation districts--subdivisions of state government. Funding for this program provides technical assistance to individual landowners and users in planning and establishing measures for erosion control, improvement of water quality, enhancement of wildlife, and support of abundant food production. Assistance is provided through local units of government.

The Soil Survey Program of the SCS is a significant national attempt to disseminate technical soils information. Landowners, operators, planners, engineers, and other officials use these data to determine suitable development sites and identify potentially critical soils. To date, 150 soil surveys have been completed and 36 are underway. Soil Surveys have not yet been initiated in 107 counties (Figure II-8).

With the enactment of the Watershed Protection and Flood Prevention Act of 1954, the SCS was given responsibility for providing technical and financial assistance to plan and initiate works of improvement in small watersheds. Local units of government must sponsor the proposed projects and are eligible for funding upon approval of the governor or state committee. Works of improvement are eligible for financial assistance based upon varying percentages. Although completed and potential watershed protection projects are found in every state of the Upper Mississippi Region progress is limited due to inadequate funding. There are 62 existing small watershed projects in the region which have adequately protected nearly 3 million acres (Figure II- 9). Completion of the 65 potential watershed projects could serve to reduce erosion and flood damage on 6 million acres (Figure II-10). Small watershed projects usually involve the construction of stabilizing structures, grassed waterways, detention basins, terraces, flood retarding structures, diversions, channel improvements, dikes, and critical area plantings.

Through the Resource Conservation and Development Program the SCS is authorized

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[26]Lindsey Grant, "Speculators in the Cornfield," (conservation viewpoint, editorial) Journal of Soil and Water Conservation, March-April 1979.

[27]U.S. Department of Agriculture, Soil Conservation Service, Abundance or Scarcity; A Matter of Inches, 1979.

TABLE II-12. GOVERNMENTAL AUTHORITY AND RESPONSIBILITY FOR EROSION AND SEDIMENTATION, UPPER MISSISSIPPI REGION

Agency	Authority[a]		Primary Program (function)
		U.S. GOVERNMENT	
DEPARTMENT OF AGRICULTURE			
Agricultural Stabilization and Conservation Service	I	Third Supplemental Appropriations Act of 1957 (P.L. 85-58)	Emergency Conservation Measures (wind erosion control)
	I	The Soil Conservation and Domestic Allotment Act (P.L. 74-46 as amended)	Agricultural Conservation Program (erosion and sediment control)
Farmers Home Administration	I	Consolidated Farm and Rural Development Act (P.L. 92-419)	Soil and Water Loans
	I	Watershed Protection and Flood Protection Act (P.L. 83-566 as amended)	Watershed Protection and Flood Prevention Loans
Soil Conservation Service	I	Soil Conservation Act of 1935 as amended, and others	Resource Conservation and Development (technical and financial assistance for sediment and erosion control)
	S	Soil Conservation and Domestic Allotment Act (P.L. 74-46)	Soil and Water Conservation (technical and advisory assistance)
	S	P.L. 74-46	Soil Survey (technical information on soil suitability)
	S,I	Watershed Protection and Flood Prevention Act (P.L. 83-566 and others)	Watershed Protection and Flood Prevention (financial and technical assistance)
	S		River Basin Surveys and Investigations (comprehensive plans for water and related land resources)
	S	Soil Conservation and Domestic Allotment Act (P.L. 74-46 and others)	Inventory and Monitoring Program (soil resource data)
Forest Service	S,I	Cooperative Forestry Assistance Act of 1978 (P.L. 95-313)	Resource Protection (technical and financial assistance)
DEPARTMENT OF THE ARMY			
Corps of Engineers	I		(maintenance channel dredging for navigation)
	R	1977 Clean Water Act, Section 4D4	(requires compliance of federal regulation for the discharge of dredge materials into navigable waters)
	E,I		(dredge materials disposal permits)
	I	1962 River and Harbor Act	Beach Erosion Control Projects
	I	1946 Flood Control Act and others	Protection of Essential Highways, Highway Bridges, Approaches, and Public Works (erosion protection)
	I	1945 River and Harbor Act (P.L. 79-14)	Protection, Clearing and Straightening Channels
	S	1974 Water Resources Development Act	Planning Assistance to States
	I	Streambank Erosion Control Evaluation and Demonstration Act of 1974	(authorizes construction of erosion control measures)
	I	Flood Control Act of 1946	(emergency streambank protection)
DEPARTMENT OF THE INTERIOR			
Geological Survey	S	Act of 1879	(operates sedimentation measurement stations)
Bureau of Mines	S	Organic Act of 1910	(contol of eroded silt from mine areas)
Bureau of Land Management	I	Federal Land Policy and Management Act of 1976	(watershed management to protect soil)
Office of Water Research and Technology	S	Water Resources Research Act of 1964	(improve methods for solving water problems)
ENVIRONMENTAL PROTECTION AGENCY	S	Clean Water Act	Water Pollution Control-State and Areawide Water Quality Management Planning Agency
			Water Pollution Control-Lake Restoration Demonstration Grants

TABLE II-12. (Continued)

Agency	Authority[a]		Primary Program(function)
		ILLINDIS	
DEPARTMENT DF AGRICULTURE	S	IL Statutes, Chapter 5	(supervises soil and water conservation districts promulgates guidelines for sediment and erosion control)
Division of Natural Resources			(administers $500,000 in cost-sharing funds for conservation tillage)
DEPARTMENT OF TRANSPORTATIDN	S,I	IL Statutes, Chapter 19 and 127	(water resource planning, Illinois and Kaskaskia waterway maintenance)
Division of Water Resources			
WATER RESOURCES CENTER	S	Water Resources Act of 1964 as amended	(water resources research)
		INDIANA	
DEPARTMENT OF NATURAL RESOURCES Division of Water	R,S,I	IND Statutes	(small watershed project studies and development, construction)
State Soil and Water Conservation Committee	S,R	IND Statutes	(organize, guide and support local conservation districts)
		IOWA	
OEPARTMENT DF AGRICULTURE	S	IA Statutes, Chapter 157	(technical assistance to Iowa Department of Soil Conservation)
DEPARTMENT OF ENVIRONMENTAL QUALITY Water Quality Commission	S R,E	IA Statutes, Chapter 455B	(agricultural chemicals management)
DEPARTMENT OF SDIL CDNSERVATION	S,R,I	IA Statutes, Chapter 83A and 467A	(administers to all aspects of soil conservation, FY 1979 $5 million in State Cost Sharing funds)
DEPARTMENT OF TRANSPDRTATION	S,E	IA Statutes, Chapter 306,3D7	(dredging in water courses)
IOWA CONSERVATION COMMISSION	S,E	IA Statutes, Chapter 106-112	(protection of habitats and scenic areas)
IDWA GEOLOGICAL SURVEY	S,I	IA Statutes, Chapter 3D5	(soil's interpretation, cooperates with USGS in collecting sediment data)
		MINNESDTA	
OEPARTMENT OF AGRICULTURE	S	MN Statutes, Chapter 17	(framework plan)
DEPARTMENT OF TRANSPORTATION	I	MN Statutes, Chapter 147	(highway erosion control program)
POLLUTION CONTROL AGENCY	S,R,E	MN Statutes, Chapter 115, 116	(nonpoint source pollution control)
SDIL AND WATER CONSERVATION BDARD	S,I	MN Statutes, Chapter 40	(disseminate information, administer state cost-sharing funds)
SOUTHERN MINNESDTA RIVERS BASIN BDARD	S	MN Statutes, Chapter 114A	(planning stream channel modification, erosion and sediment control)
WATER PLANNING BDARD			(framework plan)
WATER RESOURCES BDARD			(establishes watershed districts)

TABLE II-12. (Continued)

Agency		Authority[a]	Primary Program (function)
		MISSOURI	
DEPARTMENT OF NATURAL RESOURCES			
Division of Environmental Quality	S	Omnibus Reorganization Act of 1974	*State Cost-share Program* *Soil and Water Conservation Districts Program* *(nonpoint source pollution control, soil and water conservation districts programs)*
Highway and Transportation Department	I	MO Statutes, Chapter 226	*(highway erosion control program)*
		SOUTH DAKOTA	
CONSERVATION COMMISSION	S,R	Soil Erosion and Sediment Damage Control Act SDCL-38-8A	*(recommends setting of soil loss limits and suggests conservation practices)*
		WISCONSIN	
DEPARTMENT OF NATURAL RESOURCES	S	WI Statutes, Chapter 15	*(water quality management, nonpoint source pollution control planning)*
	I	WI Statutes	*State Nonpoint Source Pollution Abatement Program* *(administers $1.2 million in cost-sharing funds)*
BOARD OF SOIL AND WATER CONSERVATION	S,I	WI Statutes	*(development and coordination of soil erosion and sedimentation control programs)*

[a]Scope of authority is defined as follows:
S= Statutory: research, collect information, coordinate, prepare plans
R= Regulatory: establish rules and regulations, issue permits
E= Enforcement: enforce laws and regulations
I= Implementation/Construction: administer funds, acquire land, construct and operate projects

Sources: Executive Office of the President, Office of Management and Budget, 1979 Catalog of Federal Domestic Assistance, May 1979.
Upper Mississippi River Basin Commission, FY 1978 Program Report of State and Federal Water and Related Land Resources Efforts, December 1978.
Upper Mississippi River Basin Commission, Upper Mississippi River Main Stem Level B Study, Technical Paper G: Legal and Institutional, August 1979. (draft)

FIGURE II-8. STATUS OF SOIL SURVEYS, UPPER MISSISSIPPI REGION

Source: U.S. Department of Agriculture, Soil Conservation Service, *Accelerated Soil Survey* (map), State of Minnesota, October 1979; *Progress of Soil Survey* (map), State of South Dakota, January, 1979; *Status of Soil Surveys* (map), State of Illinois, October 1979; *Status of Soil Surveys* (map), State of Indiana, October, 1979; *Status of Soil Surveys* (map), State of Iowa, October, 1979; *Status of Soil Surveys* (map), State of Wisconsin, September, 1979; *Status of the National Cooperative Soil Survey in Missouri,* January, 1979.

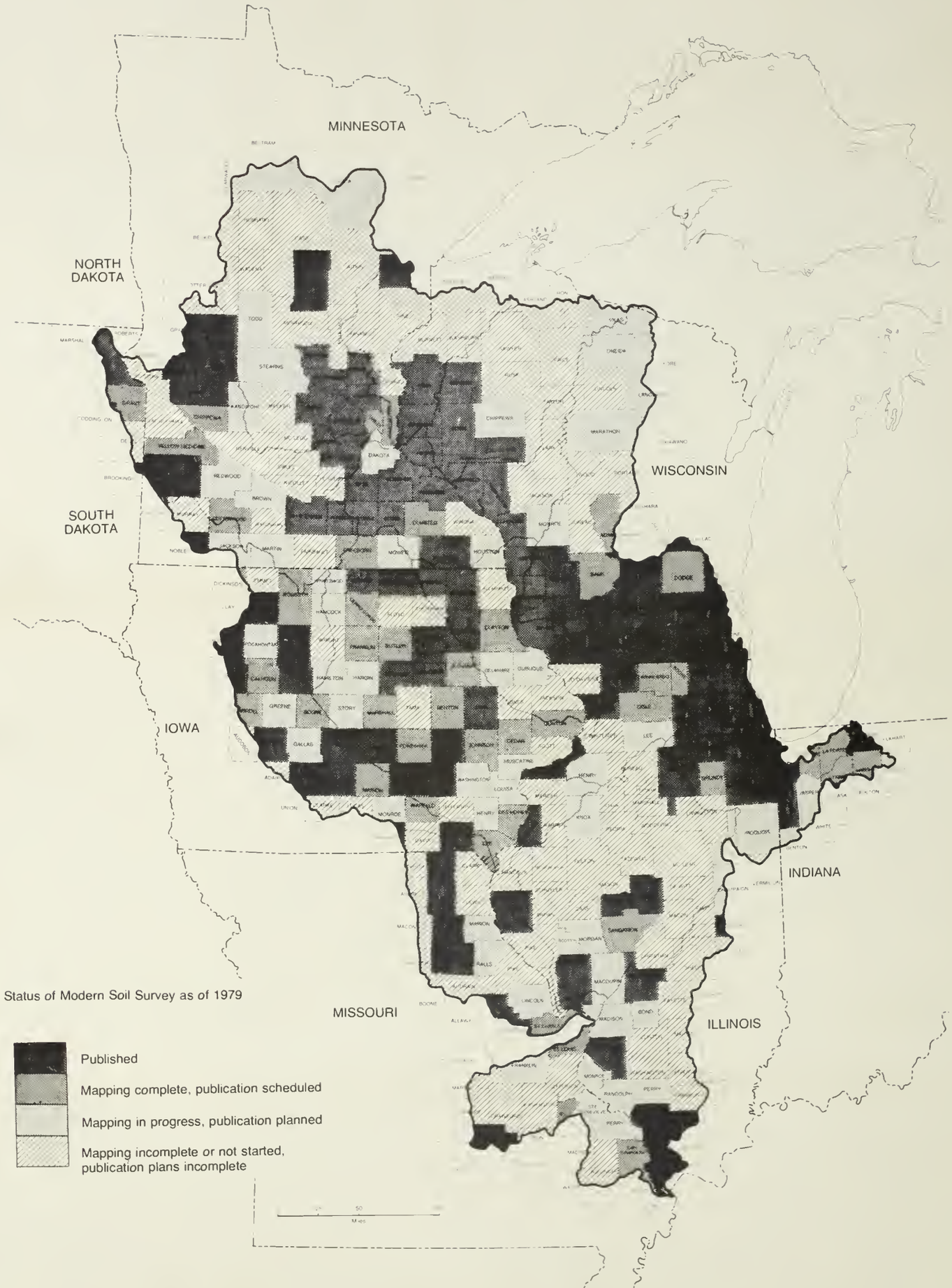

FIGURE II-8. STATUS OF SOIL SURVEYS, UPPER MISSISSIPPI REGION

Source: U.S. Department of Agriculture, Soil Conservation Service, *Accelerated Soil Survey* (map), State of Minnesota, October 1979; *Progress of Soil Survey* (map), State of South Dakota. January, 1979; *Status of Soil Surveys* (map), State of Illinois, October 1979; *Status of Soil Surveys* (map), State of Indiana, October, 1979; *Status of Soil Surveys* (map), State of Iowa, October, 1979; *Status of Soil Surveys* (map), State of Wisconsin, September, 1979; *Status of the National Cooperative Soil Survey in Missouri*, January, 1979.

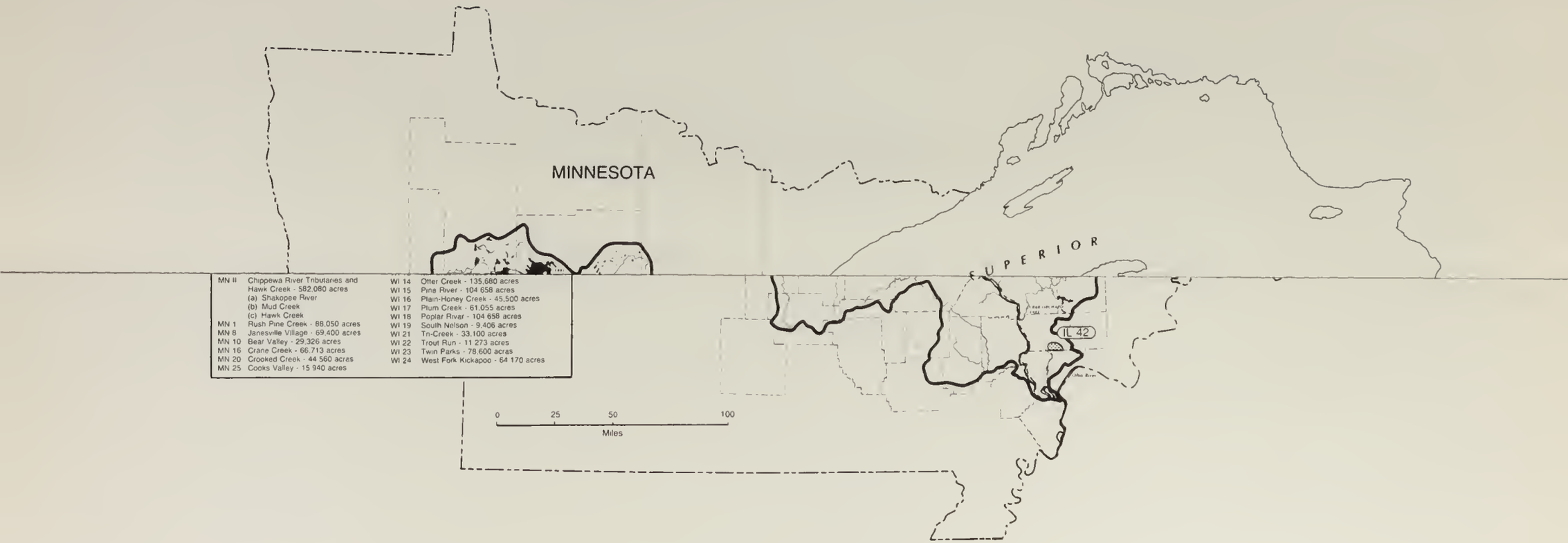
MINNESOTA
SUPERIOR
IL 42
MN II Chippewa River Tributaries and Hawk Creek - 582,080 acres
(a) Shakopee River
(b) Mud Creek
(c) Hawk Creek
MN 1 Rush Pine Creek - 88,050 acres
MN 8 Janesville Village - 69,400 acres
MN 10 Bear Valley - 29,326 acres
MN 16 Crane Creek - 66,713 acres
MN 20 Crooked Creek - 44,560 acres
MN 25 Cooks Valley - 15,940 acres
WI 14 Otter Creek - 135,680 acres
WI 15 Pine River - 104,658 acres
WI 16 Plain-Honey Creek - 45,500 acres
WI 17 Plum Creek - 61,055 acres
WI 18 Poplar River - 104,658 acres
WI 19 South Nelson - 9,406 acres
WI 21 Tri-Creek - 33,100 acres
WI 22 Trout Run - 11,273 acres
WI 23 Twin Parks - 78,600 acres
WI 24 West Fork Kickapoo - 64,170 acres
0 25 50 100
Miles

FIGURE II-9. EXISTING WATERSHED PROTECTION PROJECTS (P.L. 83-566), UPPER MISSISSIPPI REGION

Sources: U.S. Department of Agriculture, Soil Conservation Service, *Illinois Watersheds Progress Map,* 1977; *Indiana River Basin and Watershed Progress Map,* 1977; *Iowa Watershed Progress Report*, 1980; *Minnesota Watershed-River Basin Status Report*, 1980; *Missouri Status of P.L. 566 Watershed Projects,* 1978; *Watershed (P.L. 566) Projects South Dakota*, 1980; *Wisconsin Watershed Status Report,* 1979.
Personal Communication, U.S. Department of Agriculture, Soil Conservation Service, Wisconsin and Illinois, November 1980.

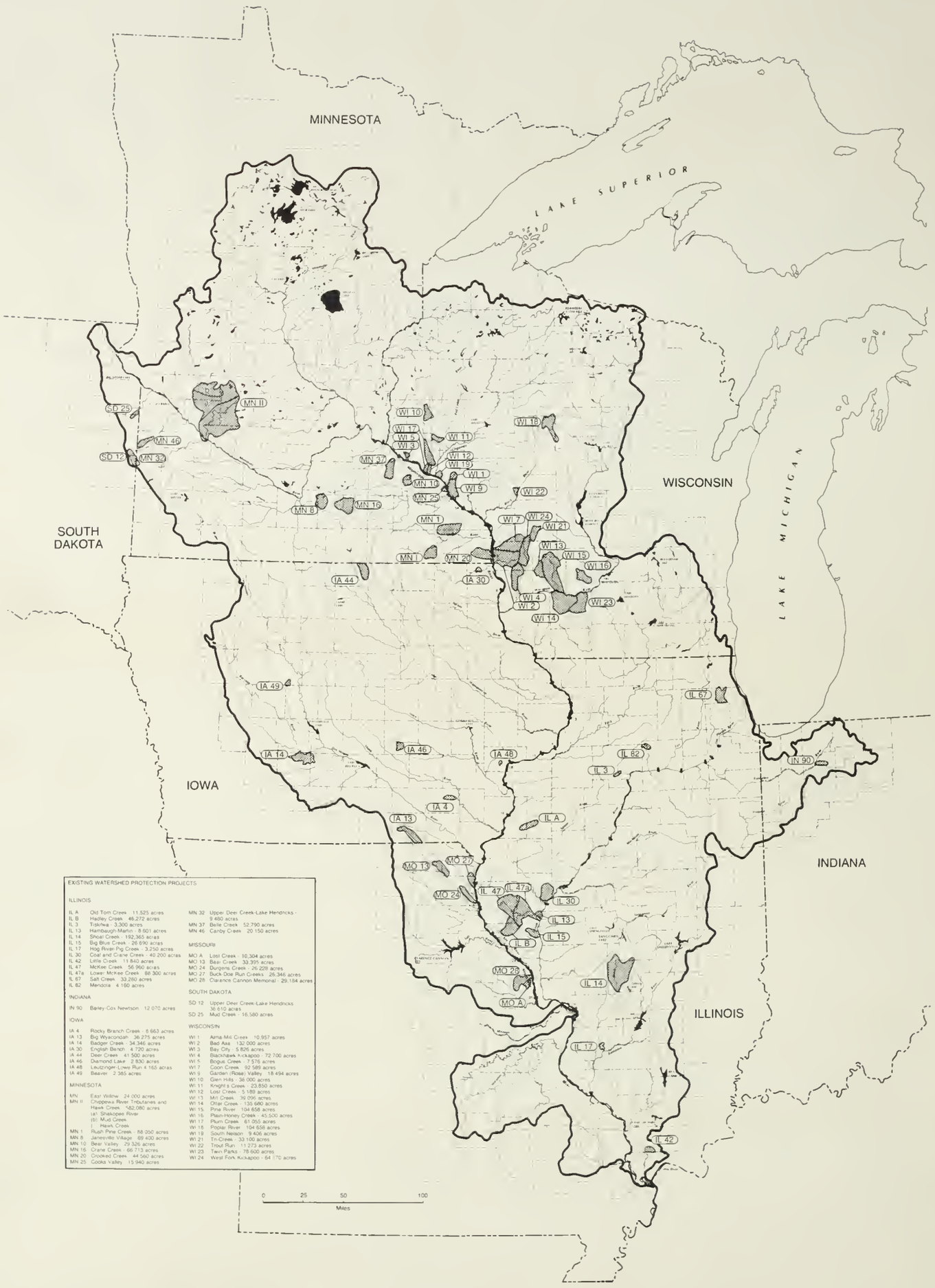
MINNESOTA
LAKE SUPERIOR
WISCONSIN
LAKE MICHIGAN
SOUTH DAKOTA
IOWA
INDIANA
ILLINOIS
SD 25
MN 11
MN 46
SD 12
MN 32
WI 10
WI 17
WI 5
WI 3
WI 11
WI 18
MN 37
WI 12
WI 19
WI 1
MN 19
WI 9
WI 22
MN 25
MN 8
MN 16
MN 1
WI 7
WI 24
WI 21
WI 13
WI 15
WI 16
MN 20
IA 44
IA 30
WI 4
WI 2
WI 23
WI 14
IA 49
IL 67
IA 46
IA 48
IL 82
IN 90
IA 14
IL 3
IA 4
IL A
IA 13
MO 27
MO 13
IL 47
IL 47a
IL 30
MO 23
IL 13
IL 15
IL B
MO 28
IL 14
MO A
IL 17
IL 42
EXISTING WATERSHED PROTECTION PROJECTS
ILLINOIS
IL A Old Tom Creek - 11,525 acres
IL B Hadley Creek - 46,272 acres
IL 3 Tiskilwa - 3,300 acres
IL 13 Hambaugh-Martin - 8,601 acres
IL 14 Shoal Creek - 192,365 acres
IL 15 Big Blue Creek - 26,690 acres
IL 17 Hog River-Pig Creek - 3,250 acres
IL 30 Coal and Crane Creek - 40,200 acres
IL 42 Little Creek - 11,840 acres
IL 47 McKee Creek - 56,960 acres
IL 47a Lower McKee Creek - 88,300 acres
IL 67 Salt Creek - 33,280 acres
IL 82 Mendota - 4,160 acres
INDIANA
IN 90 Bailey-Cox Newtson - 12,070 acres
IOWA
IA 4 Rocky Branch Creek - 8,663 acres
IA 13 Big Wyaconda - 36,275 acres
IA 14 Badger Creek - 34,346 acres
IA 30 English Bench - 4,720 acres
IA 44 Deer Creek - 41,500 acres
IA 46 Diamond Lake - 2,830 acres
IA 48 Leutzinger-Lowe Run 4,165 acres
IA 49 Beaver - 2,365 acres
MINNESOTA
MN East Willow - 24,000 acres
MN 11 Chippewa River Tributaries and Hawk Creek - 82,080 acres
(a) Shakopee River
(b) Mud Creek
(c) Hawk Creek
MN 1 Rush Pine Creek - 88,350 acres
MN 8 Janesville Village - 69,400 acres
MN 10 Bear Valley - 29,326 acres
MN 16 Crane Creek - 66,713 acres
MN 20 Crooked Creek - 44,560 acres
MN 25 Cooks Valley - 15,940 acres
MN 32 Upper Deer Creek-Lake Hendricks - 9,480 acres
MN 37 Belle Creek - 52,790 acres
MN 46 Canby Creek - 20,150 acres
MISSOURI
MO A Lost Creek - 10,304 acres
MO 13 Bear Creek - 33,395 acres
MO 24 Burgoyne Creek - 26,228 acres
MO 27 Buck Doe Run Creeks - 26,346 acres
MO 28 Clarence Cannon Memorial - 29,184 acres
SOUTH DAKOTA
SD 12 Upper Deer Creek-Lake Hendricks - 16,610 acres
SD 25 Mud Creek - 16,580 acres
WISCONSIN
WI 1 Alma-Mill Creek - 10,957 acres
WI 2 Bad Axe - 132,000 acres
WI 3 Bay City - 5,826 acres
WI 4 Blackhawk-Kickapoo - 72,700 acres
WI 5 Bogus Creek - 7,576 acres
WI 7 Coon Creek - 92,589 acres
WI 9 Garden (Rose) Valley - 18,494 acres
WI 10 Glen Hills - 36,000 acres
WI 11 Knight's Creek - 23,850 acres
WI 12 Lost Creek - 5,189 acres
WI 13 Mill Creek - 39,096 acres
WI 14 Otter Creek - 135,680 acres
WI 15 Pine River - 104,858 acres
WI 16 Plain-Honey Creek - 45,500 acres
WI 17 Plum Creek - 61,055 acres
WI 18 Poplar River - 104,656 acres
WI 19 South Nelson - 9,406 acres
WI 21 Tri-Creek - 33,100 acres
WI 22 Trout Run - 11,273 acres
WI 23 Twin Parks - 78,600 acres
WI 24 West Fork Kickapoo - 64,770 acres
0 25 50 100
Miles

FIGURE II-9. EXISTING WATERSHED PROTECTION PROJECTS (P.L. 83-566), UPPER MISSISSIPPI REGION

Sources: U.S. Department of Agriculture, Soil Conservation Service, *Illinois Watersheds Progress Map*, 1977; *Indiana River Basin and Watershed Progress Map*, 1977, *Iowa Watershed Progress Report*, 1980; *Minnesota Watershed-River Basin Status Report*, 1980; *Missouri Status of P.L. 566 Watershed Projects*, 1978; *Watershed (P.L. 566) Projects South Dakota*, 1980; *Wisconsin Watershed Status Report*, 1979.
Personal Communication, U.S. Department of Agriculture, Soil Conservation Service, Wisconsin and Illinois, November 1980.

MINNESOTA
SUPERIOR
IL 96
IA 93 Cylinder Creek - 37,272 acres
IA 97 Lost Nation - 15,840 acres
IA 98 Buffalo Bill - 3 616 acres
IA 100 West Branch of Iowa River - 99 584 acres
IA 101 German Creek 35 900 acres
IA 102 Sand Cove - 32 418 acres
IA 105 Ralston Creek - 5,621 acres
IA 106 Cedar Creek - 243 840 acres
SOUTH DAKOTA
SD 17 North Fork Whetstone River - 123,700 acres
SD 38 Yellowbank River - 249,000 acres
WISCONSIN
WI 19 Maiden Rock 845 acres
WI 23 Pheasant Branch - 16 400 acres
WI 34 Upper Sugar River - 108 490 acres
0 25 50 100
Miles

FIGURE II-10 POTENTIAL WATERSHED PROTECTION PROJECTS (P.L. 83-566), UPPER MISSISSIPPI REGION

Sources: U.S. Department of Agriculture, Soil Conservation Service, *Illinois Watersheds Progress Map,* 1977; *Indiana River Basin and Watershed Progress Map,* 1977; *Iowa Watershed Progress Report*, 1980; *Minnesota Watershed-River Basin Status Report*, 1980; *Missouri Status of P.L. 566 Watershed Projects,* 1978; *Watershed (P.L. 566) Projects South Dakota*, 1980; *Wisconsin Watershed Status Report,* 1979.

Personal Communication, U.S. Department of Agriculture, Soil Conservation Service, Wisconsin and Illinois, November 1980.

MINNESOTA
LAKE SUPERIOR
WISCONSIN
LAKE MICHIGAN
SOUTH DAKOTA
IOWA
INDIANA
ILLINOIS
SD 17
SD 38
MN 65
MN 67
MN 64
MN 56
MN 59
MN 70
MN 61
MN 60
MN 52
WI 19
MN 44
MN 35
MN 45
MN 54
MN 48
IA 102
IA 67
IA 34
IA 93
IA 100
WI 23
WI 34
IA 69
IA 92
IA 73
IA 76
IA 79
IL L
IL N
IL M
IL 99
IL O
IL 98
IN 104
IN 107
IN 114
IN 109
IN 111
IN 116
IN 108
IA 97
IA 98
IA 105
IA 101
IA 106
IA 24
IA 57
IA 54
IA 58
MO 42
MO 20
MO 30
MO 62
MO 60
MO 70
MO 85
MO 43
MO 61
MO 44
MO 86
IL 95
MO 87
MO 76
MO 73
IL 96
POTENTIAL WATERSHED PROTECTION PROJECTS
ILLINOIS
IL L Des Plaines River (Upper) 86 163 acres
IL M Poplar Creek 25 500 acres
IL N North Branch Chicago River 65 300 acres
IL O Cal Sag Channel 74 800 acres
IL 95 Bay Creek-Pike Co 11 000 acres
IL 98 Little Calumet River 136 500 acres
IL 99 Des Plaines River 428 400 acres
INDIANA
IN 104 Mill Creek 187 136 acres
IN 107 Upper Kankakee River 234 287 acres
IN 108 Lower Yellow River 87 452 acres
IN 109 Upper Yellow River 185 300 acres
IN 111 Robbins 56 680 acres
IN 114 Kankakee River-Porter Co 151 570 acres
IN 116 Machler Ditch 36 400 acres
IOWA
IA 24 Soap Creek 161 955 acres
IA 34 Dixon 2 795 acres
IA 54 North Wyaconda
IA 57 White Breast Creek 64 400 acres
IA 58 Indian Creek Van Buren 47 200 acres
IA 67 Buffalo Grove 2 305 acres
IA 69 Monroe 8 647 acres
IA 73 Honeycomb 900 acres
IA 76 Union 692 acres
IA 79 Avery Bullrock Creek 48 297 acres
IA 92 Prairie Creek 21 671 acres
IA 93 Cylinder Creek 37 272 acres
IA 97 Inoi Nation 15 840 acres
IA 98 Buffalo Bill 616 acres
IA 100 West Branch of Iowa River 99 584 acres
IA 101 German Creek 3 900 acres
IA 102 Sand Hollow 12 418 acres
IA 105 Ralston Creek 5 621 acres
IA 106 Cedar Creek 243 840 acres
MINNESOTA
MN 35 South Zumbro 200 540 acres
MN 44 Hankcom Creek 11 800 acres
MN 45 Cedar Valley 11 481 acres
MN 48 Thompson Valley 24 500 acres
MN 52 Spring Creek 16 688 acres
MN 54 Turtle Creek 96 000 acres
MN 56 Three-Mile Creek 73 000 acres
MN 59 Jack Creek 124 992 acres
MN 60 Okabena Creek 88 768 acres
MN 61 Heron Lake 82 860 acres
MN 64 Upper Yellow Medicine 157 824 acres
MN 66 West Branch of the Mustinka 128 448 acres
MN 67 Yellow Bank River 10 500 acres
MN 70 South Fork Watonwan 129 920 acres
MISSOURI
MO 20 North Wyaconda 52 185 acres
MO 30 Upper Middle Fabius 164 084 acres
MO 42 Indian Creek 3 707 acres
MO 44 Little Wyaconda-Sugar Creek 93 064 acres
MO 60 Grassy Troublesome Creeks 125 255 acres
MO 61 Honey-Sugar Creek 55 515 acres
MO 62 Lower Middle Fabius 102 997 acres
MO 70 Little Fabius 44 298 acres
MO 73 Peruque Creek 52 900 acres
MO 76 Pike-Spencer 239 746 acres
MO 85 North River 242 500 acres
MO 86 Middle Fork of Salt River 225 730 acres
MO 87 Crooked and Other Creeks 137 570 acres
SOUTH DAKOTA
SD 17 North Fork Whetstone River 123 700 acres
SD 38 Yellowbank River 249 000 acres
WISCONSIN
WI 19 Maiden Rock 845 acres
WI 23 Pheasant Branch 16 400 acres
WI 34 Upper Sugar River 26 490 acres
0 25 50 100
Miles

FIGURE II-10 POTENTIAL WATERSHED PROTECTION PROJECTS (P.L. 83-566), UPPER MISSISSIPPI REGION

Sources: U.S. Department of Agriculture, Soil Conservation Service, *Illinois Watersheds Progress Map*, 1977; *Indiana River Basin and Watershed Progress Map*, 1977; *Iowa Watershed Progress Report*, 1980; *Minnesota Watershed-River Basin Status Report*, 1980; *Missouri Status of P.L. 566 Watershed Projects*, 1978; *Watershed (P.L. 566) Projects South Dakota*, 1980; *Wisconsin Watershed Status Report*, 1979.
Personal Communication, U.S. Department of Agriculture, Soil Conservation Service, Wisconsin and Illinois, November 1980.

to assist local citizens in initiating long-range programs for developing a dynamic rural community, with stable income levels and environmental balance. In the region 20 programs are active and 7 programs are inactive (Figure II-11). The important elements of this program attempt to control sediment and erosion while improving water quality. Although minimally funded in recent years, this program has provided a significant opportunity to educate the urban and rural public to the costs of unchecked erosion and sedimentation and the benefits of conserving the soil and water resources.

The U.S. Department of Agriculture, Agricultural Stabilization and Conservation Service (ASCS), remains the main source of direct cost-sharing assistance for conservation and production measures to private land and farm operators. The Agricultural Conservation Program provides payment for erosion and sediment control measures ranging from 30 to 90 percent depending upon the priority of the practice used. In addition, payment will be made to operators who improve water quality. A controversial provision in the program provides funding assistance to farmers for production and maintenance of yields. In the past, farmers were eligible to purchase seed, fertilizer, limestone, and to install drainage systems. In some cases these efforts actually serve to hasten the erosion process.

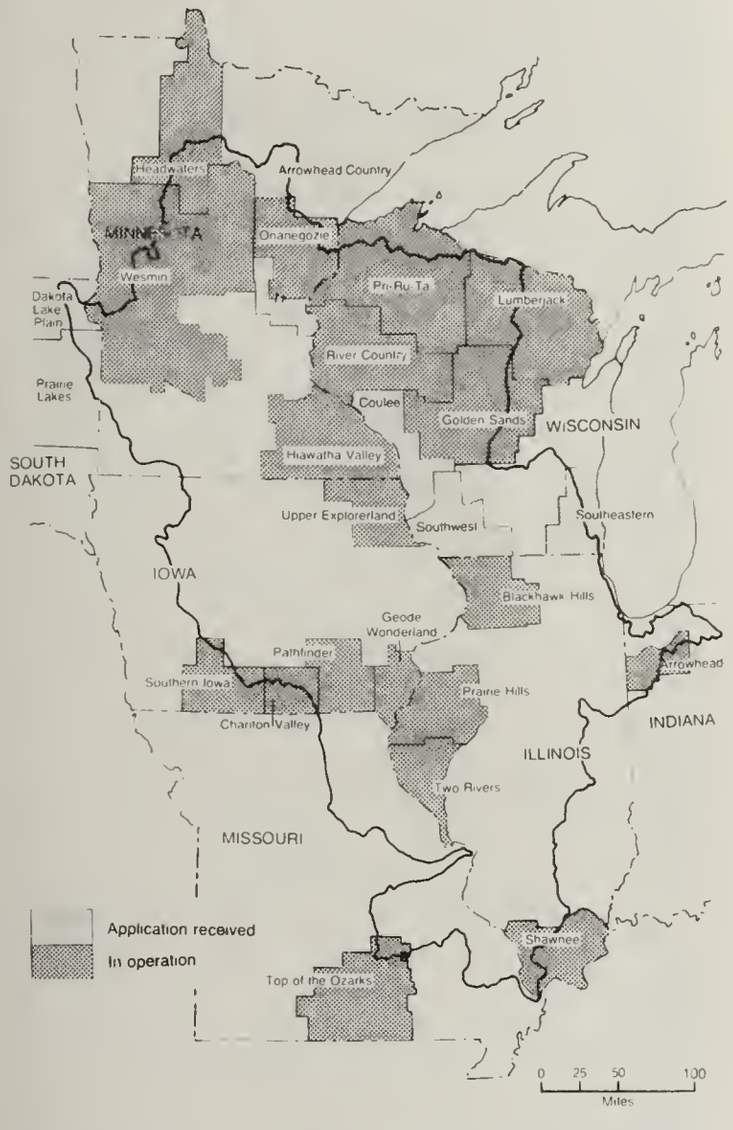

FIGURE II-11. STATUS OF RESOURCE CONSERVATION AND DEVELOPMENT AREAS, UPPER MISSISSIPPI REGION

Sources: U.S. Department of Agriculture, Soil Conservation Service, *Resource Conservation and Development Program, Progress Reports*, Illinois; Indiana; Iowa; Minnesota; Missouri; South Dakota; Wisconsin, 1976-1977.

The Rural Clean Water Program under the administration of the ASCS is designed to implement recommendations of the 208 Water Quality Management Plans. Objectives of the program are aimed at improving water quality using BMPs to reduce critical soil erosion which carries sediment, farm chemicals, and animal wastes. However, the $50 million national funding the program received in FY 1980 is minimal for a $10 billion problem need.[28]

The U.S. Department of Agriculture, Forest Service (FS) plans and manages land and water resources for watershed protection on national forestlands and grasslands. Through the state and private forestry programs the FS assists the SCS in the Watershed Protection and Flood Prevention and Resource Conservation and Development programs and provides financial and technical assistance to state forestry organizations. The FS also conducts water, forage, timber, wildlife, and recreation research.

The U.S. Army Corps of Engineers is responsible for the maintenance of the navigation channel in the Upper Mississippi and Illinois river systems. Dredging and the disposal of dredged material are required in many locations in these systems in order to provide safe navigation and protect national security. Section 404 of the Federal Water Pollution Control Act as amended in 1972, gave authority to the Corps to regulate

[28]James Risser, "Rural Soil, Water Efforts Get No Boost in Carter Budget," Des Moines Register, 29 January 1980.

the discharge of dredged material in the waters of the United States in order to protect the channel and biological integrity of U.S. waters.

The multiple authorities of the Corps allows for development and evaluation of new methods and techniques for streambank protection and provides technical assistance to public agencies for preventing shoreline and streambank erosion.

Other programs of the Department of Interior, U.S. Geological Survey, Bureau of Mines, Bureau of Land Management, Office of Water Research and Technology, and the Water Resources Council serve to provide research and funding for measures to diminish erosion and sediment problems.

The states traditionally have followed the lead of the federal government in erosion control efforts. Most states have soil and water conservation boards which help administer USDA programs and guide the efforts of local soil and water conservation districts. Recently several states have initiated their own erosion control cost-sharing programs under the realization that federal funding has fallen far short of money needed adequately address the problems.

The Division of Natural Resources of the Illinois Department of Agriculture (ILDA) administers the Illinois Soil and Water Conservation Districts Law and establishes regulations for limiting soil erosion. Districts are charged by the State of Illinois with the responsibility of protecting and developing the renewable natural resources within their jurisdictions. They also assist in providing supplemental land surveys, and preliminary investigations on approved watersheds, and in providing for cooperation with the U.S. Soil Conservation Service in the preparation of watershed plans and designs for improvement works.

The Soil and Water Conservation Committee in Illinois is responsible for the organization of county soil and water conservation districts. These districts are organized throughout the state, and are directed to carry out their operations in accordance with the law. Some of the duties of the committee are to assist interested local groups in organizing new districts, help districts plan and revise their long-range programs, provide conservation information to news media throughout the state, facilitate the acceleration of small watershed planning, and to develop state and district sediment control guidelines.

The Iowa Department of Soil Conservation is responsible for the administration of the State Soil Conservation Laws and agricultural nonpoint source planning. The State Soil Conservation Committee establishes the policy for the Department of Soil Conservation. Iowa has led the way in providing cost-sharing funds for conservation measures. The program provides 50 percent cost-sharing for the installation of voluntary cost-sharing measures while it provides 75 percent funding for mandatory erosion control. The Iowa Soil Loss Limitation Program monitors erosion throughout the state.

The Iowa Natural Resources Council (INRC) is authorized to establish and enforce regulations to utilize and protect the surface water and groundwater resources of the state. The Resources Council also establishes and administers comprehensive statewide programs for the conservation development and use of state waters.

The Soil and Water Conservation Board, within the Minnesota Department of Natural Resources (Mn DNR), serves as the parent agency to the 92 soil and water conservation districts that cover the state. Responsibilities of the Board are to provide administrative and financial assistance to the local conservation districts control and prevention of soil erosion, land resource planning and development, and implementation of conservation practices that effectively reduce siltation and loss of land base. The Mn DNR also evaluates federal projects to assure that they reflect the concerns of state programs and public interests. Cost-sharing assistance is provided by the state to land occupants to establish permanent conservation measures. Current funding is at $3.3 million per biennium.

The Minnesota Pollution Control Agency (MPCA) is responsible for nonpoint source pollution control planning in Minnesota. Under the program the MPCA is assessing roadside erosion and its effects on water quality, describing and evaluating current programs related to roadside erosion, and developing, in cooperation with state and local authorities, strategies for correcting water quality problems identified.

The Missouri Department of Natural Resources (Mo DNR) has the responsibility

to assure the wise use of the state's land resource. Recently completed, a draft of the State Water Quality Management Plan has addressed erosion and sedimentation as they affect water quality. Best Management Practices have been recommended which will control non-point source pollution originating as agricultural erosion. The Mo DNR, Division of Environmental Quality is also responsible for providing leadership to the state soil and water conservation districts.

The South Dakota Legislature passed the Soil Erosion and Sediment Damage Control Act in 1976. This Act recommends the setting of soil loss limits and other conservation standards according to guidelines developed with public participation by the Conservation Commission. The guidelines developed by the Commission consist of recommended soil loss limits and suggested conservation practices.

The Wisconsin Department of Natural Resources (Wis DNR) provides the administrative leadership to the locally organized soil and water conservation districts and directs the State Water Quality Management Program for the state. The Wis DNR also evaluates the federal projects and assures that they reflect the concerns of state programs and public interests. The Board of Soil and Water Conservation Districts supervises and coordinates the efforts of the soil and water conservation districts in Wisconsin.

Production Scenarios

The USDA, through the authority of the Soil and Water Resources Conservation Act, developed an analytical model of alternative agricultural production scenarios for the United States.[29] This model was then adapted for an analysis of agricultural production in the Upper Mississippi Region. The primary purpose of this model is to assess the effects of erosion on crop yields and production costs, and to determine the appropriate conservation measures needed to sustain production and meet export needs. The model selects the least costly means of producing the required output given the nation's production goals and the varying costs, erosion rates, and yield levels for each activity. The model cannot and is not intended to duplicate the real world. Because data and analytical constraints always limit the realism of a model, the results cannot be taken as absolute measures of impacts. Instead, the results indicate the expected direction of response and the relative magnitude of that response.

The effects of erosion under three alternative erosion levels and two production scenarios (1977 Export Level and Moderate Export Increase Scenario) were analyzed. The "Long-Term Economic Level," (LTEL) is the basis for both production scenarios. This level refers to an economic optimum solution which selects the least costly array of cropping and treatment alternatives that will satisfy agricultural demands for the year 2000. Under this level soil conserving activities are selected only if they are the least costly means of meeting national demand for agricultural production. For example, if the requirement is to produce 1 bushel of corn, the model searches for the soil where corn production costs are lowest. As progressively higher levels of production are required, the model extends corn production into soils where production costs per unit of yield are progressively higher. It adjusts production patterns to reflect where the major crops can be most cheaply grown and chooses the most efficient use of such factors as fertilizers, land, water, and conservation measures.

Forestland projections for the year 2000 vary from cropland projections in that the forestry data were developed from trends. Two levels of production are shown for forestland in the year 2000 and approximate the 1977 Export Level and Moderate Export Increases Scenarios used in cropland projection. However, because the projections are based on anticipated changes, no adjustments were made in resources used in production or intensity of management to meet projected demands. Therefore forestland production, even under the higher level of production does not meet the regions requirements shown in OBERS E population projections. (OBERS E projections are based on a replacement level fertility, four percent unemployment, continued technological

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[29]The Resources Conservation Act analysis used the CARD-USDA National Agricultural Linear Programming Model.

progress, and capital accumulation, and an increase in per man output of 2.9 percent annually.) To meet the OBERS demands will require an increase in the high level of timber management.

1977 Export Level Scenario

The 1977 Export Level Scenario assumes domestic needs will be met through 2000 and exports will continue at about the 1977 level (Table II-13). Under this scenario no more cropland will be needed and an increased domestic demand will be attained through new technology. Agricultural productivity is projected to increase by 1.1 percent per year to 2000.

Erosion is reduced by more than 75 percent from the 1977 gross erosion tonnage under the LTEL. This reduction is the result of changing cropping practices from straight row cropping to conservation tillage (Figure II-12). As erosion is reduced to 30 or 60 percent beyond the LTEL more intensive and expensive conservation practices will be needed such as contouring, stripcropping, and terracing. Fertilizer use will drop slightly at all treatment levels, however, pesticide use will increase because of the need for chemical pest control on minimally tilled acreage.

Crop production goals can be met at the three alternative erosion levels under the 1977 Export Level Scenario. However, production tradeoffs are being made such as producing more cover crops instead of row crops in order to meet the erosion goals (Table II-14). Production costs are lower under the LTEL than they were in 1977 (Table II-15). Production costs rise only slightly for some products at the 30 percent beyond LTEL. Production costs are higher at the 60 percent beyond LTEL.

TABLE II-13. EFFECTS OF EROSION CONTROL ON CROPLAND, FERTILIZER, AND PESTICIDE USE IN 2000, 1977 EXPORT LEVEL, UPPER MISSISSIPPI REGION

	1977 Level	LTEL[a]	Erosion Reduced 30% beyond LTEL	Erosion Reduced 60% beyond LTEL
		(thousands)		
Cropland				
Oryland (acres)	54,255	54,049	53,496	53,385
Reserve (acres)	2,260	2,471	3,025	3,186
Erosion (tons)	469,916	115,958	80,554	46,031
Fertilizer Use (1977 dollars)	1,704,804	1,688,007	1,633,295	1,611,683
Pesticide Use (1977 dollars)	562,912	683,595	682,090	673,278

[a]LTEL refers to Long-Term Economic Level or economic optimum

Source: U.S. Department of Agriculture, Soil and Water Resources Conservation Act: 1980 Appraisal Part II, 1980. (review draft)

Moderate Export Increase Scenario

The Moderate Export Increase Scenario assumes that domestic needs will be met through 2000 and exports will increase moderately. Agricultural productivity is projected to increase by 1.1 percent per year along with an annual increase in exports of 2.3 percent to 2000. Production costs and prices will also increase under this scenario. In order to meet production demands, cropland will be used more intensively.

Under the LTEL approximately 3 percent more acreage will be added to meet the year 2000 production demands (Table II-16). Erosion would be reduced to 25 percent of the 1977 level. If erosion is reduced 30 percent beyond the LTEL

TABLE II-14. ESTIMATED AGRICULTURAL PRODUCTION IN 2000 UNDER VARIOUS LEVELS OF EROSION CONTROL, 1977 EXPORT LEVEL SCENARIO, UPPER MISSISSIPPI REGION

	1977 Level	LTEL[a]	Erosion Reduced 30% beyond LTEL	Erosion Reduced 60% beyond LTEL
		(thousands)		
Corn (bu)	2,637,642	2,699,335	2,732,614	2,662,230
Oil Meal (ton)	211,027	227,245	233,144	233,510
Wheat (bu)	313,428	277,863	215,722	213,660
Oats (bu)	407,847	379,217	334,827	390,082
Hay (ton)	31,018	31,909	32,118	31,820
Barley (bu)	30,431	78,435	87,497	106,031
Silage (ton)	28,715	19,031	19,129	20,714
Pasture (ton)	8,773	8,773	8,773	8,773

[a]LTEL refers to Long-Term Economic Level or economic optimum

Source: U.S. Department of Agriculture, Soil and Water Resources Conservation Act: 1980 Appraisal Part II, 1980. (review draft)

TABLE II-15. EFFECTS OF EROSION CONTROL ON PRODUCTION COSTS OF AGRICULTURE PRODUCTS IN 2000, 1977 EXPORT LEVEL SCENARIO, UPPER MISSISSIPPI REGION

	1977 Level	LTEL[a]	Erosion Reduced 30% beyond LTEL	Erosion Reduced 60% beyond LTEL
		(1977 dollars)		
Corn (bu)	1.11	1.05	1.10	1.20
Oil Meal (CWT)	5.13	4.91	5.25	5.73
Wheat (bu)	1.91	1.87	2.04	2.24
Oats (bu)	0.88	.99	1.15	1.02
Hay (ton)	26.43	26.05	23.92	25.27
Barley (bu)	0.89	.77	1.19	0.95
Silage (ton)	9.98	9.25	10.23	11.50
Pasture (ton)	30.03	26.93	23.30	24.07

[a]LTEL refers to Long-Term Economic Level or economic optimum.

Source: U.S. Department of Agriculture, Soil and Water Resources Conservation Act: 1980 Appraisal Part II, 1980. (review draft)

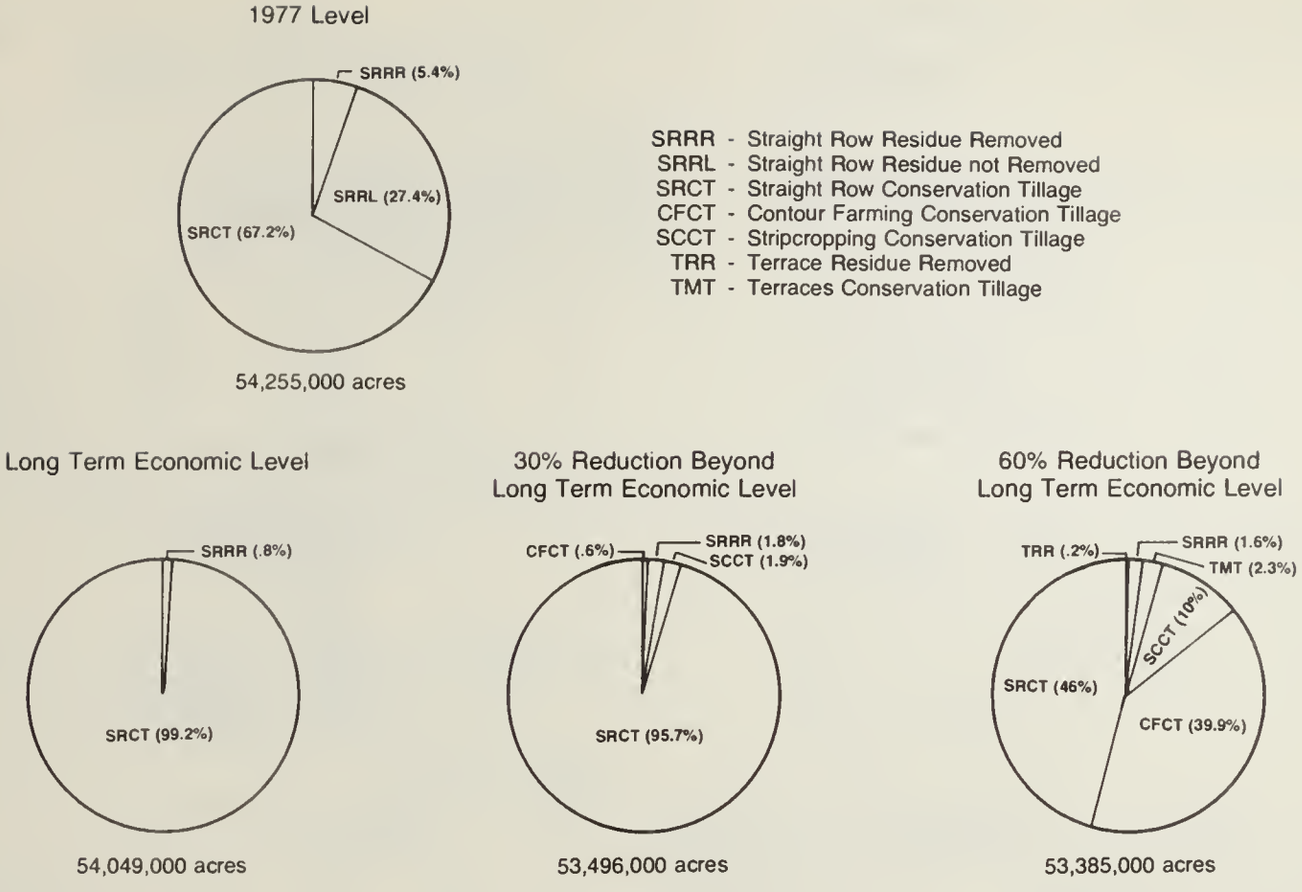

FIGURE II-12. CONSERVATION PRACTICES NEEDED AT ALTERNATIVE LEVELS OF EROSION, 1977 EXPORT LEVEL SCENARIO, UPPER MISSISSIPPI REGION

Source: U.S. Department of Agriculture, *Soil and Water Resources Conservation Act: 1980 Appraisal, Part II*, 1980. (review draft)

TABLE II-16. EFFECTS OF EROSION CONTROL ON CROPLAND, FERTILIZER, AND PESTICIDE USE IN 2000, MODERATE EXPORT INCREASE SCENARIO, UPPER MISSISSIPPI REGION

	1977 Level	LTEL[a]	Erosion Reduced 30% beyond LTEL	Erosion Reduced 60% beyond LTEL
		(thousands)		
Cropland				
Dryland (acres)	54,255	55,876	55,881	-
Reserve (acres)	2,260	1,417	1,412	-
Erosion (tons)	469,916	119,290	83,503	-
Fertilizer Use (1977 dollars)	1,704,804	1,776,444	1,760,071	-
Pesticide Use (1977 dollars)	562,912	723,353	751,136	-

[a]LTEL refers to Long-Term Economic Level or economic optimum

Source: U.S. Department of Agriculture, Soil and Water Resources ConservationAct: 1980 Appraisal Part II, 1980. (review draft)

slightly more acreage will be utilized and erosion will be reduced to 18 percent of the 1977 level. However, a 60 percent reduction in erosion beyond the LTEL could not be attained and still meet increased export demands. Cropping practices will be altered from straight row cropping to conservation tillage, contouring, and stripcropping. Nearly 2.3 percent of the cropland will be terraced (Figure II-13). Increased fertilizer and pesticide use will be necessary to meet increased agricultural production demands.

Production goals can be met at the LTEL and 30 percent beyond the LTEL (Table II-17). However, production costs rise sharply under a moderate export increase for most products (Table II-18).

Forestland disturbance classes remain essentially the same under the two export scenarios (Table II-19). However, disturbance classes change significantly as the erosion reduction levels change.

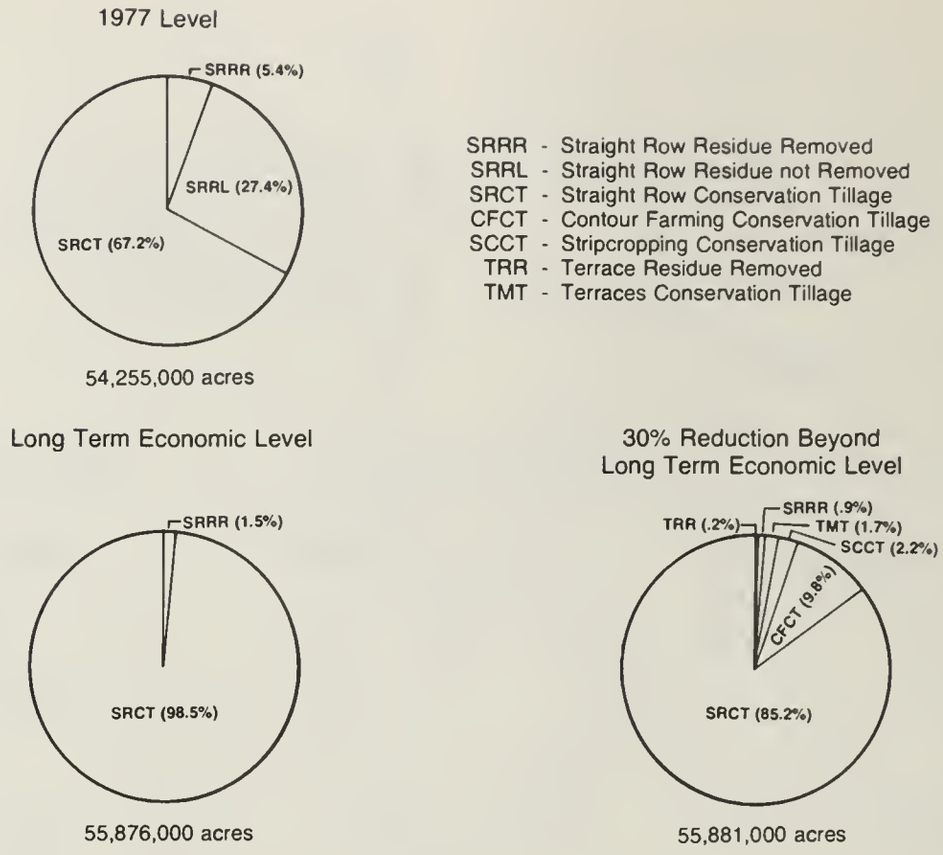

FIGURE II-13. CONSERVATION PRACTICES NEEDED AT ALTERNATIVE LEVELS OF EROSION, MODERATE EXPORT INCREASE SCENARIO*, UPPER MISSISSIPPI REGION

*Production demands cannot be met at 60 percent erosion reduction

Source: U.S. Department of Agriculture, *Soil and Water Resources Conservation Act: 1980 Appraisal, Part II*, 1980. (review draft)

In order to attain either the 1977 export level or a moderate export increase and reduce erosion to 30 or 60 percent beyond the LTEL it will be necessary to substantially reduce grazing on forestland and return it to an undisturbed status.

Alternative Solutions and Effects

Alternatives to solve erosion and sedimentation problems in the Upper Mississippi Region focus on retention of topsoils through conservation practices. The complete control of erosion is not always possible or practical, so sedimentation alternatives are proposed which will minimize the adverse environmental effects of sediments. The major erosion and sedimentation problems occurring in the Upper Mississippi Region are the following:

(1) Agricultural erosion. Cropland erosion averages greater than 6 tons per acre per year. The continued loss rate of topsoils will severely diminish agricultural productivity capability by the year 2000.

(2) Sedimentation of lakes and streams. Erosion of fine organic soils results in the transport of sediments through water courses into lakes, streams, and backwaters. Suspended and deposited

TABLE II-17. ESTIMATED AGRICULTURAL PRODUCTION IN 2000 UNDER VARIOUS LEVELS OF EROSION CONTROL, MODERATE EXPORT INCREASE SCENARIO, UPPER MISSISSIPPI REGION

	1977 Level	LTEL[a]	Erosion Reduced 30% beyond LTEL	Erosion Reduced 60% beyond LTEL
		(thousands)		
Corn (bu)	2,637,642	3,167,463	3,315,594	-
Oilmeal (tons)	211,027	195,226	212,435	-
Wheat (bu)	313,428	277,782	132,085	-
Oats (bu)	407,847	429,706	413,156	-
Hay (ton)	31,018	32,808	32,829	-
Barley (bu)	30,431	73,248	76,785	-
Silage (ton)	28,715	18,674	19,146	-
Pasture (ton)	8,773	8,773	8,773	-

[a]LTEL refers to Long-Term Economic Level or economic optimum

Source: U.S. Department of Agriculture, Soil and Water Resources Conservation Act: 1980 Appraisal Part II, 1980. (review draft)

TABLE II-18. EFFECTS OF EROSION CONTROL ON PRODUCTION COSTS OF AGRICULTURAL PRODUCTS IN 2000, MODERATE INCREASE SCENARIO, UPPER MISSISSIPPI REGION

	1977 Level	LTEL[a]	Erosion Reduced 30% beyond LTEL	Erosion Reduced 60% beyond LTEL
		(1977 dollars)		
Corn (bu)	1.11	1.55	1.58	-
Oilmeal (CWT)	5.13	7.81	7.90	-
Wheat (bu)	1.91	3.16	3.24	-
Oats (bu)	.88	1.33	1.39	-
Hay (ton)	28.43	35.64	37.21	-
Barley (bu)	.89	1.88	1.85	-
Silage (ton)	9.98	13.08	13.77	-
Pasture (ton)	30.03	45.71	40.73	-

[a]LTEL refers to Long-Term Economic Level or economic optimum

Source: U.S. Department of Agriculture, Soil and Water Resources Conservation Act: 1980 Appraisal Part II, 1980. (review draft)

TABLE II-19. FORESTLAND DISTURBANCE CLASSES AT ALTERNATIVE EXPORT AND EROSION CONTROL LEVELS, UPPER MISSISSIPPI REGION

	Oisturbance Classes				
	Undisturbed	Managed Logging	Unmanaged Logging	Grazed	Grazed and Logged
			(percent)		
1977	79	*	1	19	*
1977 Export Level Scenario					
LTEL[b]	81	*	1	16	*
30% beyond LTEL	86	2	*	11	*
60% beyond LTEL	91	2	*	6	0
Moderate Export Increase Scenario					
LTEL	81	*	2	16	*
30% beyond LTEL	86	2	*	11	*
60% beyond LTEL	91	2	*	6	0

[a]For 21,057,000 acres in the region
[b]LTEL refers to Long-Term Economic Level or economic optimum
*less than 1 percent

Source: U.S. Department of Agriculture, Soil and Water Resources Conservation Act: 1980 Appraisal, Part II, 1980. (review draft)

sediments diminish water quality, degrades fish and wildlife habitat, and causes accelerated eutrophication.

(3) Streambank and lakeshore erosion. Erosion occurring on streambanks and lakeshores is the result of inadequate management practices and increased flows. Permitting livestock grazing on streambanks, deforestation, and cropping accelerates the erosion process and permits the influx of sediments.

(4) Sedimentation of the navigation channel. Course sandy sediments originating on streambanks are the major source of channel shoaling. Sediments are expensive to remove and can severely diminish the quality of habitat and recreational areas.

Export level scenarios previously presented show that generally the most cost-effective way of reducing erosion is through the use of conservation tillage, contouring, and management. These measures are used first in the model as the means for reducing erosion. The model selects erosion control measures on the basis of cost and does not consider public acceptability. The model projects the use of more expensive measures, such as strip-cropping and terracing, only when less expensive measures will not achieve the desired level of erosion reduction. Objectives of an erosion control program must recognize the need to meet potential export demands while maximizing soil savings. The most cost-effective alternative for erosion reduction appears to be the LTEL with 30 percent erosion reduction. While all export demands could be met, erosion could be reduced by 83 percent over the 1977 erosion level. Corn production costs would slightly decrease at this level but marginal production cost increases would affect oilmeal, wheat and other grains and feed production. Although moderate export increases could be attained at a 30 percent reduction beyond the LTEL, substantially higher production cost would be incurred.

Erosion reductions will alter forestland disturbance classes. The greatest need is a reduction in grazed forestland. A reduction from 16 to 11 percent grazed will reduce erosion 30

percent. A further reduction to 6 percent grazed will reduce forest erosion 60 percent.

The range of costs for land treatment varies according to the specific measures applied. Stripcropping is a relatively inexpensive treatment measure costing about $5 per acre while terracing may cost more than $400 per acre. Converting land to permanent cover averages about $70 per acre.[30] While conservation tillage practices do not require alteration to the land, farm operators may need to invest in new machinery.

Long-range benefits are derived from conservation practies, although there may not be a short-term gain to the owner and operator. The conservation of soils will improve water quality and increase infiltration. Lower long-term farm production costs, increased farm output, and reduced water treatment needs are other long-term benefits. In addition, fish and wildlife will benefit from improved habitat and spawning conditions.

Landowners and farm operators need to cooperate to apply soil conservation techniques and install soil conservation measures on critically eroding farm land (Table II-20). However, the present financial status of farms in general prohibits conservation efforts because of rising land and production costs. An integral component of any soil preservation program must include substantial funding for conservation cost-sharing. Federal cost-sharing programs currently provide payments of 30 to 90 percent of the cost depending upon the practice used.

Improved federal tax incentives along with a 75 to 90 percent costsharing arrangement will be necessary for an effective erosion control program. In addition, an increase in the $3500 cost-share limit may provide for more widespread application.

Development of a federal "Green Ticket" program could provide the economic incentives necessary for farmers to voluntarily apply conservation practices to their land. Under this program, the farmer would sign an agreement with the local soil and water conservation district. Completion of these conservation measures would qualify the farmer for larger price support payments, additional crop insurance, and lower interest rates for loans.

Soil erosion is a subtle process occurring almost imperceptively in some cases. Losses in soil productivity because of erosion are nearly unnoticeable, especially when massive amounts of fertilizers are applied. The payoff for a conservation program cannot be measured in terms of improved national or regional production over the next 20 or even 50 years. Rather, the benefits of such a program will accummulate in the 50 to 100 year period when as much as 2 to 4 inches of the most productive soil are preserved. Less fertilizers would be needed to keep the soil productive in addition to substantial savings in the energy required.

In FY 1978 funding for soil conservation from all sources totaled $108.3 million for the region.[31] The USDA has determined that eight to ten times the current funding level is needed to reduce erosion to acceptable levels. In order to adequately address the problem, approximately $50 billion will be needed over the next 50 years.

Iowa and Minnesota should consider the expansion of their soil conservation cost-sharing program as a supplement to federal assistance. Illinois and Missouri should adequately fund their cost-sharing program to achieve greater participation. Wisconsin should modify its program to permit soil conservation as a fundable item.

The staffing of local soil conservation agencies is sometimes inadequate to properly identify the soil erosion problems. In some areas an increase of personnel in conservation agencies is required in order to inform the public of the hazards and costs of erosion. Technical advice is generally needed to apply the necessary erosion controlling measures. Payments for additional staffing could come from local and state governments through a cost-sharing arrangement with the federal government. An improved environment and production levels could economically benefit the region.

Water quality management planning efforts at statewide and areawide levels

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[30]Treatment costs are averages from the U.S. Department of Agriculture, Soil Conservation Service.

[31]U.S. Department of Agriculture, op. cit., footnote 16.

TABLE II-20. ALTERNATIVE SOLUTIONS TO EROSION AND SEDIMENTATION: ANALYSIS AND EVALUATION[a], UPPER MISSISSIPPI REGION

Alternative Solution (Problem Addressed)	Four Account Effects				Evaluation			Conclusion
	NED	EQ	RED	OSE	Planning Objective	Effi-ciency	Accept-ability	
(1) Accelerate federal funding for the application of land management practices on agricultural land where sheet and gully erosion are severe. A "Green Ticket" program in addition to expanded federal tax incentives and cost-sharing (75-90 percent) could effectuate land treatment (Agricultural erosion; Sedimentation of lakes and streams)	+ agricultural output - national cost + energy + navigation + reduced disaster assistance	+ surface water quality + fish & wildlife habitat + erosion control + sediment control	+ jobs - local cost - state cost + economic stability + flood damage reduction	+ aesthetics + health & safety	NEO,EQ	High	High	Recommended
(2) Accelerate funding of state conservation cost-sharing programs. The establishment and/or expansion of cost-sharing programs in Iowa, Minnesota, Illinois, Missouri, and Wisconsin would complement federal incentives (Agricultural erosion; Sedimentation of lakes and streams)	+ agricultural output + energy + navigation + reduced disaster assistance	+ surface water quality + fish & wildlife + erosion control + sediment control	+ jobs - local cost - state cost + economic stability + flood damage reduction	+ aesthetics + health & safety	NED,EQ	High	High	Recommended
(3) Provide additional local staffing of conservation agencies to identify erosion problems, inform landowners and farm operators, and apply the necessary controlling measures in problem areas (Agricultural erosion; Sedimentation of lakes and streams)	- national cost + reduced disaster assistance	+ surface water quality + fish & wildlife habitat + instream flows	+ jobs - local cost - state cost + water supply + flood damage reduction	+ aesthetics + health & safety + recreation	EQ,NS	Medium	High	Conditionally Recommended
(4) Accelerate the Rural Clean Water Program to accomplish the widespread adoption of Best Management Practices from the areawide and statewide 208 Water Quality Planning Programs (Agricultural erosion; Sedimentation of lakes and streams)	+ agricultural output - national cost + reduced disaster assistance	+ surface water quality + erosion control + sediment control	+ jobs + economic stability - state cost + flood damage reduction	+ real income	EQ	High	High	Recommended
(5) Accelerate the application of streambank protection measures such as rip-rapping, streambank crossings, reforestation, and seeding to reduce channel maintenance problems and improve regional water quality (Streambank and lakeshore erosion; Sedimentation of lakes and streams; Sedimentation of navigation channel)	+ agricultural output - national cost	+ surface water quality + fish & wildlife habitat + erosion control + sediment control	- local cost + jobs - state cost	+ real income	EQ	High	High	Recommended
(6) Implement mandatory erosion control regulations limiting soil erosion to tolerable levels (Agricultural erosion; Sedimentation of lakes and streams)	+ navigation + energy + reduced disaster assistance	+ surface water quality + fish & wildlife habitat + natural areas + erosion control + sediment control	- local cost + jobs - state cost + flood damage reduction	+ aesthetics + recreation	EQ,NS	High	Low	Not Recommended
(7) Accelerate the Soil Survey Program to provide urgently needed information to carry out agricultural land utilization and development programs (Agricultural erosion; Sedimentation of lakes and streams)	+ agricultural output - national cost + energy + navigation + reduced disaster assistance	+ surface water quality + fish & wildlife habitat + instream flows + erosion control + sediment control	- local cost + jobs - state cost + economic stability + flood damage reduction	+ aesthetics + health & safety + real income + recreation	NEO,NS	High	High	Recommended
(8) Adopt conservation practices by farm producers in the region which are needed to attain the Long-Term Economic Level (Agricultural erosion; Sedimentation of lakes and streams)	- national cost + agricultural output + navigation + energy + reduced disaster assistance	+ natural areas + erosion control + sediment control + fish & wildlife habitat + surface water quality + instream flows	+ jobs + flood damage reduction + water supply - local cost - state cost	+ real income + health & safety + recreation	NEO,EQ	High	Medium	Conditionally Recommended
(9) Adopt conservation practices by farm producers in the region which are needed to attain a 30 percent erosion reduction beyond the Long-Term Economic Level (Agricultural erosion; Sedimentation of lakes and streams)	- national cost + agricultural output + navigation + energy + reduced disaster assistance	+ natural areas + erosion control + sediment control + fish & wildlife habitat + surface water quality + instream flows	+ jobs + flood damage reduction + water supply - local cost - state cost	+ real income + health & safety + recreation	NEO,EQ	High	Medium	Conditionally Recommended
(10) Adopt conservation practices by farm producers in the region which are needed to attain a 60 percent erosion reduction beyond the Long-Term Economic Level (Agricultural erosion; Sedimentation of lakes and streams)	- national cost - agricultural output + navigation + energy + reduced disaster assistance	+ natural areas + erosion control + sediment control + fish & wildlife habitat + surface water quality + instream flows	+ jobs + flood damage reduction - local cost - state cost + water supply	+ real income + health & safety + recreation	NEO,EQ	Medium	Low	Not Recommended
(11) Accelerate implementation of Small Watershed Projects. Completion of projects in the region will help protect nearly 6 million acres from severe erosion hazards. (Agricultural erosion; Sedimentation of lakes and streams; Streambank and lakeshore erosion)	- national cost + agricultural output + reduced disaster assistance	+ fish & wildlife habitat + surface water quality + instream flows + erosion control + sediment control	+ flood damage reduction + jobs - local cost - state cost	+ real income + health & safety	NEO,EQ	High	Medium	Conditionally Recommended

TABLE II-20. (Continued)

Alternative Solution (Problem Addressed)	Four Account Effects				Evaluation			Conclusion
	NED	EQ	RED	OSE	Planning Objective	Efficiency	Acceptability	
(12) Continue financial and technical assistance to sponsors of Resource Conservation and Development (RC&D) areas to inform the public on erosion and controlling measures (Agricultural erosion; Streambank and lakeshore erosion)	- national cost + agricultural output + reduced disaster assistance	+ fish & wildlife habitat + surface water + erosion control + sediment control	+ flood damage reduction + jobs	+ real income + health & safety	NED,NS	Medium	High	Recommended
(13) Accelerate sediment research to improve the understanding of its sources, its transport mechanisms and its potential beneficial uses (Sedimentation of lakes and streams; Sedimentation of navigation channels)	- national cost + navigation + agricultural output + reduced disaster assistance	+ fish & wildlife habitat + natural areas + instream flows + sediment control	+ jobs + economic stability + flood damage reduction - state costs	+ aesthetics + real income + recreation	EQ	Medium	High	Recommended
(14) No action	- agricultural output - energy - navigation + reduced disaster assistance	- fish & wildlife habitat - surface & ground water quality - natural areas - instream flows - erosion control - sediment contol	- jobs - economic stability - water supply - flood damage reduction	- real income - health & safety - recreation		Low	Low	Not Recommended

[a]Abbreviations in the Table: NED (National Economic Development), EQ (Environmental Quality), RED (Regional Economic Development), OSE (Other Social Effects), NS (Nonstructural), XX (Not applicable)

For complete definition of Effects, Planning Objectives, Efficiency, Acceptablility, and Conclusions see Appendix E.

have determined that about one half of the sediments delivered to the regions waters originate from cropland. Water quality is severely diminished by suspended sediments in water which also transports harmful nutrients and pesticides. Accelerated funding for the Rural Clean Water Program (RCWP) is necessary to accomplish the widespread adoption of Best Management Practices (BMPs) which the water quality planning programs have recommended. BMPs generally consist of any suitable practice which will reduce sheet, rill, and gully erosion and provide stable watercourses for runoff. BMPs and conservation practices are very similar measures. Conservation practices can range from energy saving and inexpensive minimum tillage techniques to elaborate and expensive grade stabilization structures (Table II-21). The applicability of these measures will depend upon the land use, gradient, and severity of current erosion. Those measures which require physically altering the land feature or adding a structure are expensive and nearly cost-prohibitive without some form of subsidy. Measures such as grassing of waterways and permanent cover techniques are less expensive initially, but long-term removal of the land from production provides no economic return for the investment. Funding for the RCWP for the nation was at $50 million in FY 1980. Full funding of this program will be needed to reduce sediment related water quality problems within the next 10 years. The application of BMPs could reduce erosion by as much as 70 percent.

Illinois, Iowa, Minnesota, and Missouri have state-assisted soil conservation cost-sharing programs. Wisconsin cost-share funds of $1.2 million can be used only to control nonpoint source pollution. Statewide funding for the Iowa program amounts to $8 million dollars for 1980 and $3.3 million for Minnesota for the last biennium. Illinois and Missouri recently adopted statewide soil conservation cost-sharing programs that will provide funding for the installation of conservation practices but were only marginally funded in 1980. Additional funding of these state programs could provide the necessary incentive for farm operators to take steps to protect the soil resource. Since agriculture is an important part of the region's economic base, soil is perhaps the most valuable resource of these states. Cost-sharing programs could work in conjunction with the federal programs or provide financial incentives beyond federal contributions in order to make adequate progress. Significant environmental benefits will be realized with additional soil resource protection. Along with substantially improved water quality, fish and wildlife habitat will be protected and enhanced.

TABLE II-21. EROSION AND SEDIMENT CONTROL MEASURES

Method or Measure	Specifications
Conservation Cropping System	Control soil loss by establishment of strip cropping, terracing, contouring, etc.
Conservation Tillage	Planting with soil disturbance only at seed row; a protective cover of crop residue is left on the surface for erosion control
Contour Farming	Guidelines laid out on contour with maximum deviation not to exceed 2 percent
Contouring Orchards	Guidelines laid out on contours with maximum deviation not to exceed 1-2 percent depending on drainage character of soil
Cover and Green Manure Crop	Following harvest, the seed bed is prepared according to type of cultivation being followed
Critical Area Planting	Prepare seed bed according to condition of the site and type of vegetative cover to be established
Crop Residue Use	Leave plant residues on the surface or incorporated in the surface until planting time for the next crop
Debris Basin	Capacity must be equal to expected volume of sediment to be trapped or if periodically removed, the capacity can be reduced proportionately
Diversion	Location of a diversion and outlet must be in compliance with state drainage and water laws and by outlet conditions, topography, land use, necessary cultural operations, soil type and length of slope
Drainage, Field Ditch	Surface field ditches must be planned as integral part of a drainage system for the field served shall collect and remove water to an outlet with continuity and without ponding; they should be as straight as topography and property boundaries permit
Drainage, Land Grading	Designed slope and dimension limitations shall be those found suitable for the particular site conditions, conservation system or land use to be applied
Floodwater Retarding Structure	Inasmuch as the design criteria for this measure are so varied and numerous, it is recommended that only an engineer or other qualified person undertake its design
Grade Stabilization Structure	Inasmuch as the design criteria for this measure are so varied and numerous, it is recommended that only an engineer or other qualified person undertake its design
Grassed Waterway or Outlet	Design for ten-year frequency storm with temporary dike protection to develop vegetative cover
Heavy Use Area Protection	If the area use will permit sufficient plant covers to prevent erosion, a vegetative cover of various types may be used; however, if the area is to be paved, the site must be prepared and surfacing laid within recommended engineering practices
Livestock Exclusion Fencing	Establish any permanent fence properly braced and capable of turning livestock
Minimization of Stripped Areas	Careful programming of a development may enable the developer to reduce the area stripped of vegetation at one time
Mulching	Straw, hay or other suitable commercial mulch should be applied at 2 tons of air-dry material per acre or according to manufacturer's direction at any time soil and site conditions are suitable for spreading and anchoring
Recreation Area Stabilization	Provisions must be made for surface and subsurface drainage as needed and for disposal of runoff without erosion; all paving and site preparation must follow good engineering practices
Seeded Areas Protected by Matting	Choose either a mesh matting where no mulching is required or a blanket-type where mulching effect is required
Stream Bank Protection	Since each reach of channel is unique, measures for protection must be according to a plan and adopted to the specific site. Because of the numerous techniques available, further detail will not be provided here
Strip Cropping, Contour	Planting of crops and tillage operations are parallel to strip boundaries which should be laid out on the contour with an allowable deviation of 2 percent, or 3 percent for short distances toward grass waterways or to adjust for ridges; widths of strips decrease with increased slope; steep and waterway areas should be left in grass
Strip Cropping, Field	Planting of crops and tillage operations are parallel to strip boundaries which should be laid out parallel to contour with an allowable deviation of 2 or 3 percent for short distances toward grass waterways or to adjust for ridges; widths of strips decrease with increased slope; steep and waterway areas should be left in grass
Temporary Roads on Construction Sites	Temporary roadways should be carefully graded to drain transversely
Terrace Gradient	Should not be constructed on soils that are too stony, steep or shallow to permit practical and economic installation; the topography must allow farmable terrace construction and grass backslopes must be provided where slope exceeds ten percent
Tree Planting	Species should be selected according to site conditions effect wanted produced; the site must be prepared in accordance to species' needs and undesired species removed or controlled

Source: Southwestern Illinois Metropolitan and Regional Planning Commission. Plan for Major Drainage: The American Bottoms and Hillside Drainage Area. August 1975. (adapted from: Madison County Soil and Water Conservation District, Illinois. Technical Guide: Section IV, Standards and Specifications. Revised March 1975.)

The most severe problem affecting river and navigation channel shoaling is streambank erosion. Sands and gravels from unprotected streambanks are continually eroding and being transported downstream. When the current of the channel slows sufficiently, as it does behind the dams of the Mississippi and Illinois rivers, the sand load is deposited. In contrast, most of the organic and fine soil sediments remain suspended until they reach backwaters or until the current is slowed even further. These heavier sediments are the major obstacle to channel maintenance, therefore greater protection should be provided along riverbanks which are eroding severely. Accelerated funding for the Army Corps of

Engineers, to provide streambank erosion control protection may be necessary to accelerate streambank protection efforts.

Recreational and development activities also induce erosion. Lakeshore erosion controlling measures are necessary on many miles of shoreland in the region. In agricultural areas livestock crossing, fencing, reforestation, and riprapping are techniques most often employed to control the problem. However, current methods of treatment are costly and sometimes ineffective.

The implementation of mandatory national erosion control laws would require landowners, farm producers, land developers and contractors to keep soil loss on their lands to within tolerable limits. Provisions in the law would have to recognize farm economics. The farmer is largely unable to justify such measures, therefore it is necessary to subsidize their installation. The cost of regulating such a program would probably not justify its existence. Many acres of land currently in production would be idled by such a program but it would be difficult or impossible to enforce. More prudent spending of funds may be achieved if the money was used to provide technical advice to farm operators. In the case of developers and resource extracting operations, the added cost of erosion control and reclamation is added to the product cost.

The report of the 1977 Resources Conservation Act showed that 42 million acres of Class 2e, 3e, and 4e lands were eroding above tolerable limits. Gross erosion on these soils is nearly 320 million tons per year. By reducing erosion on these soils to within tolerable limits a very large percentage of the gross soil erosion in the region could be halted. State and local soil and water conservation boards should recognize these lands need priority land treatment. Although costs for conservation measures on these lands will be expensive in the most severely eroding areas, optimum benefits will be realized in soil preservation and water quality enhancement.

Acceleration of the USDA Soil Survey program would provide detailed soils maps and interpretation needed to carry out various types of agricultural and non-agricultural land utilization and development programs. The program is expected to cost approximately $32 million.

Implementation of the 65 proposed P.L. 566 Small Watershed Projects will result in an additional 6 million acres being adequately treated. In addition to production and water quality benefits, flood damages will be reduced. A temporary decrease in water quality during construction is a possible adverse effect of watershed protection measures. Estimated costs for implementing these projects may be as much as $400 per acre, however, costs will vary depending upon the treatment measures employed.

Resource Conservation and Development Program efforts serve to accelerate land treatment measures by providing leadership and the financial resources necessary to meet planning objectives. The program provides a low cost opportunity to inform the public of erosion hazards and effective economical means to protect severely eroding areas.

Efforts could be expanded to understand and control the movement of sediments in the Mississippi River system. The establishment of additional gaging stations may provide the data needed to analyze suspended sediments, bed material, and bedloads. With these data a sediment transport capacity model could be developed to correlate surface erosion rates with carrying capacity and provide the necessary information to treat the most critical watersheds.[32]

GREAT I has identified dredged materials disposal sites that could be made available for beneficial uses. Through the modification of the wing dam and closing dam systems, bedload material may be deposited near selected placement sites. This could reduce channel maintenance costs and make more material available for beneficial uses.[33]

The potential uses of fine grain sediments could be examined to determine their economic and environmental benefits. Uses such as cropland application and the enhancement of local hardwood forest habitat may provide an avenue to

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[32]Great River Environmental Action Team, GREAT II Main Report, December 1980.

[33]Great River Environmental Action Team, A Study of the Upper Mississippi River: GREAT I Main Report, September 1980.

justify dredging of backwaters.[34] In addition sediments could be used as daily cover materials for sanitary landfills.

Conclusion

Without the implementation of any erosion and sedimentation alternative no new programs will be initiated to conserve soil and funding for current programs will remain at the present level. Under the "no action" plan, erosion and sedimentation will continue to damage water quality as well as disrupt the fish and wildlife habitat. The most severe effect of this alternative will be the long-run degradation of soil productivity. Increased production costs, greater energy consumption, and decreased economic stability will also adversely affect the region.

The implementation of mandatory erosion control regulations is not recommended because such regulations would require farmers and landowners to install soil conservation measures which they cannot always economically justify. These regulations would require a complex and expensive reporting network and funding for such a program would be better spent on the actual installation of conservation measures.

An economic optimum solution is one which will reduce erosion to the greatest practical level by selecting the least costly cropping and treatment measures and yet will satisfy agricultural demands for the year 2000. Conservation practices should be adopted by farmers in the region which are needed to attain up to a 30 percent erosion reduction beyond the Long-Term Economic Level. Erosion reduction beyond this level will not satisfy agricultural demands.

The most significant element of the soil conservation effort has been the soil conservation cost-sharing programs. Past efforts, however, have been slowed by the limited availability of funds. Therefore, federal and state soil conservation cost-sharing programs should be accelerated through the availability of expanded funding to landowners and farm operators.

The establishment of a voluntary federal "Green Ticket" program is recommended as a means to encourage soil conservation through tax credits, higher prices supports, and other incentives. This voluntary approach may provide the additional incentives needed for the widespread application of soil conservation measures.

Streambank erosion is a persistent problem and one which is not easily halted. Because many miles of streambanks are eroding in the region, adjacent landowners are urged to apply streambank protection measures. The U.S. Army Corps of Engineers should concentrate efforts to reduce erosion on the Upper Mississippi River Mainstream and States and the U.S. Department of Agriculture should make funds available for the application erosion controlling measures on tributary streams. Streams and rivers should be targeted where sediments are seriously affecting the navigation channel, habitat, and aesthetics. The Corps should be given the authority to study and evaluate measures such as a sediment transport capacity model to help determine the major sources of sediment in the region. Evaluating the operation of wing and closing dams so that sediments deposited at selected sites may provide long-term economic benefits to channel maintenance problems. The investigation of the uses of fine sediments is supported as a means to improve agriculture and wildlife habitat.

Acceleration of the Soil Survey Program for the region is recommended because basic soils data are needed to make conservation decisions. Funding for the completion of P.L. 566 Small Watershed Projects is a sound and effective means to ensure erosion control on a watershed level if public cooperation is received. Although these projects are expensive, treatment of seriously eroding land is imperative. Resource Conservation and Development areas should continue to be funded because they inform landowners and farm operators on opportunities and technical assistance in the application of land treatment.

An evaluation of the personnel requirements and needs of local soil and water conservation agencies is necessary to accelerate the identification of critically eroding areas. Upon the completion of this evaluation additional staff should be provided in those areas most in

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[34]Great River Environmental Action Team, op. cit., footnote 32.

need to accelerate the technical assistance for landowners and farm operators in treating their land. The Rural Clean Water Program should be reauthorized and funded as a means to reduce critical soil erosion and enhance water quality. This program is needed to encourage and assist landowners and farm operators in adopting the BMPs recommended in water quality management plans.

FLOOD DAMAGE

Current Conditions and Problems

Flood damages are extensive in the Upper Mississippi Region. Floodwaters threaten lives, disrupt communities, and cause large financial losses. These damages have continued to rise despite increasing expenditures for flood control. Although floods are caused by a combination of factors, the major reason for flood damages is the conflict between urban and agricultural development along waterways and the natural phenomenon of rivers overtopping their banks.

Average annual flood damages in the region are estimated at $421 million (1980 dollars). Approximately half of these are agricultural damages ($211 million), which include replanting and refertilizing costs, reduced crop yields, and loss of animal pasture days (Figure II-14).

Floods also damage property in urban areas, causing an estimated $111 million in losses annually (26 percent of the regional average annual damages). Residences, businesses, industries, and schools are damaged by flooding. Urban flooding also disrupts business and other community activities and requires emergency and clean-up funds.

Damage to rural non-crop areas, transportation facilities, and utilities amounts to an estimated $99 million annually (23 percent of the regional average annual damages). Damages to farm buildings, equipment, livestock, poultry, and drainage and irrigation facilities constitute rural non-crop damages. Also included are erosion damages, sediment deposition on cropland, and damage to industrial and commercial facilities located in rural areas.

Average annual damage figures do not reflect the complexity of flood problems and their effects on people. Floods may be of long or short duration and may cause direct or indirect damages. The frequency, severity, and duration of flooding and the types and value of floodplain development will determine the effect on a particular community. An example is flash floods which are usually of short duration but can cause extensive property damage and endanger lives. Flash floods are frequent in the hilly areas of southeast Minnesota, southwest Wisconsin, and northeast Iowa. Approximately 270 municipalities within the region have had flash floods identified.[35]

The most extensive flooding occurs in the southern half of the region, particularly in the Lower Illinois and Kaskaskia-Meramec river basins (Figure II-15). Approximately 42 percent of the region's damages occur in these basins. In the Lower Illinois River Basin large agricultural damages result from flooding in upstream areas and along downstream portions of the Illinois and Sangamon Rivers.[36] The lower 80 miles of the

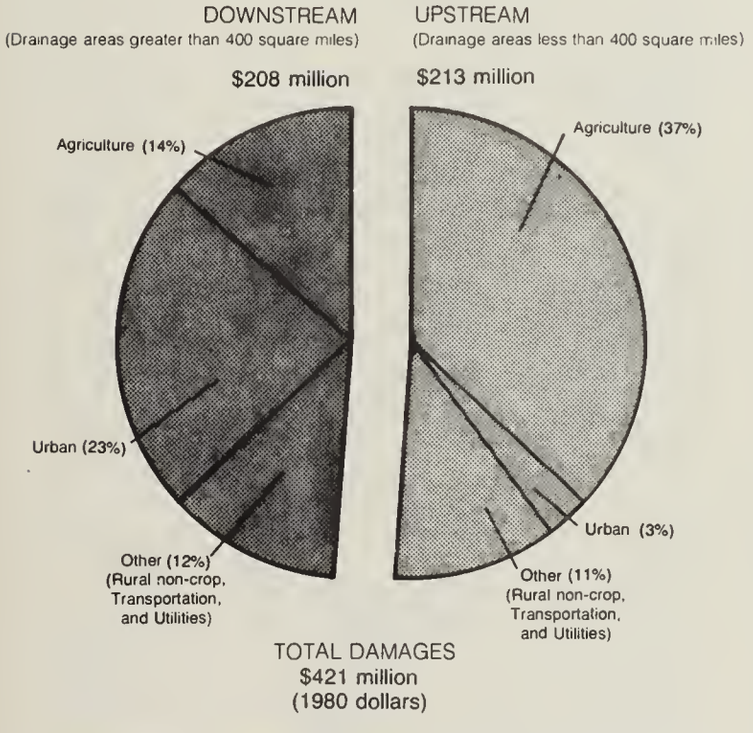

FIGURE II-14. AVERAGE ANNUAL FLOOD DAMAGES BY LAND USE, UPPER MISSISSIPPI REGION

*Estimated for 1975 levels of floodplain development

Sources: UMRCBS Coordinating Committee, *Upper Mississippi River Comprehensive Basin Study* (Vol V), 1970.
U.S. Water Resources Council, *1975 National Water Assessment: Flood Damage Cost Methodology*, 1976.

[35]Personal communication with the National Weather Service, River Forecast Center, May 1980.

[36]Upstream areas are watersheds less than 400 square miles in size. Downstream watersheds are those greater then 400 square miles.

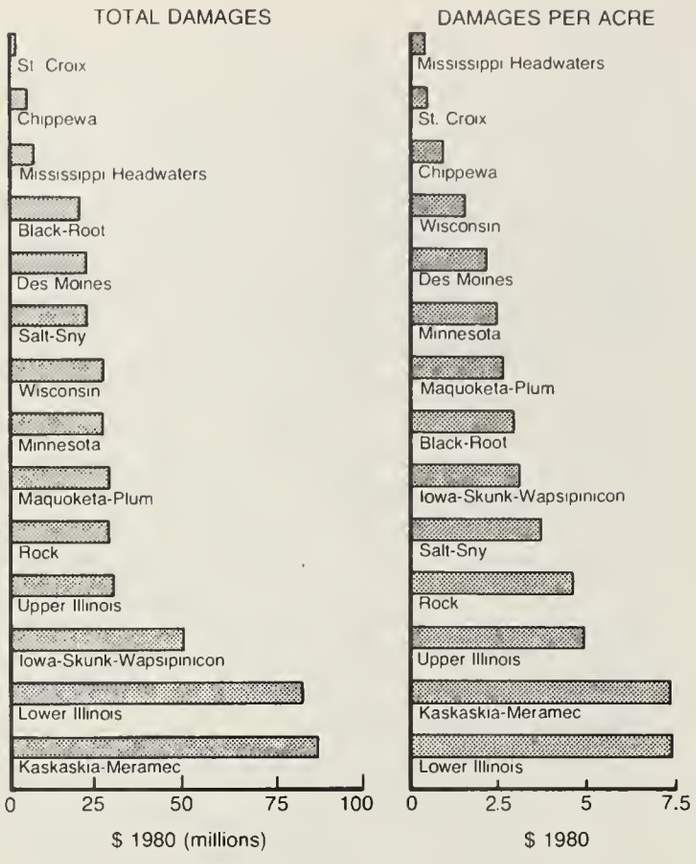

FIGURE II-15. AVERAGE ANNUAL FLOOD DAMAGES BY SUBREGION*, UPPER MISSISSIPPI REGION

*Data based on 1975 development conditions.

Source: UMRCBS Coordinating Committee, *Upper Mississippi River Comprehensive Basin Study*, (Vol. V), 1970.

Illinois River cause an estimated $6.1 million in damages annually. In the Kaskaskia-Meramec River Basin flooding of downstream urban areas is a major problem. Rapid expansion of the St. Louis metropolitan area onto highly flood-prone land has significantly increased susceptibility to flooding.

Many other areas throughout the region experience severe flood problems (Figure II-16). The 1978 floods in southeast Minnesota caused fatalities and immense financial losses. Flooding of the Rock River in northern Illinois causes frequent problems. Along the lower portion of the Rock River (river miles (13-52) damages average an estimated $4.0 million annually. Severe flooding also occurs on the Cedar River in Iowa. Average annual damages are estimated at $6.6 million along the reach between Cedar Rapids and the Shell Rock River (mile 106-201). Levee projects underway in Waterloo and Evansdale will prevent some of these damages.

Although flooding is primarily a natural occurrence, the damages caused by flooding have been aggravated by human activities. Continuing encroachment of urban development onto floodplains is the major cause of flood damage. Some floodplain development is necessary where industries depend on the river for water supply or navigation. Floodplains bordered by steep bluffs often provide the only suitable location for construction. Much unnecessary development occurs, however, out of ignorance of the hazard. When floods occur after development of the area, lives and property are endangered and additional state, local, and federal funds are required for disaster assistance and flood control.

In addition to increasing the vulnerability to floods, floodplain encroachment destroys the floodplain's ability to provide temporary floodwater storage. When floodplains are filled or altered by construction, movement of floodwaters onto the floodplain is impeded, resulting in greater flood peaks and velocities. The floodplain's vegetation and permeable soils also moderate flood peaks by retarding flow of overland runoff into the river channel. Development of the floodplain increases runoff by replacing vegetation and permeable soils with impervious surfaces.[37]

Continued development also impairs the floodplain's role in protecting water quality, facilitating groundwater recharge, and moderating low flows. The floodplain filters sediment, nutrients, toxins, and pathogens carried in runoff and incoming floodwater. As the floodplain vegetation slows runoff or floodwaters, sediments and other pollutants are deposited. During periods of high water, floodwater is stored in the floodplain, purified as it infiltrates through the alluvium, and added to groundwater supplies. During periods of low flow, groundwater is discharged through the floodplain to augment streamflow and to reduce the frequency and duration of low flows.

In addition to their hydrologic value, floodplains support large and diverse populations of plants and ani-

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[37]U.S. Water Resources Council, A Unified National Program for Floodplain Management, September 1979.

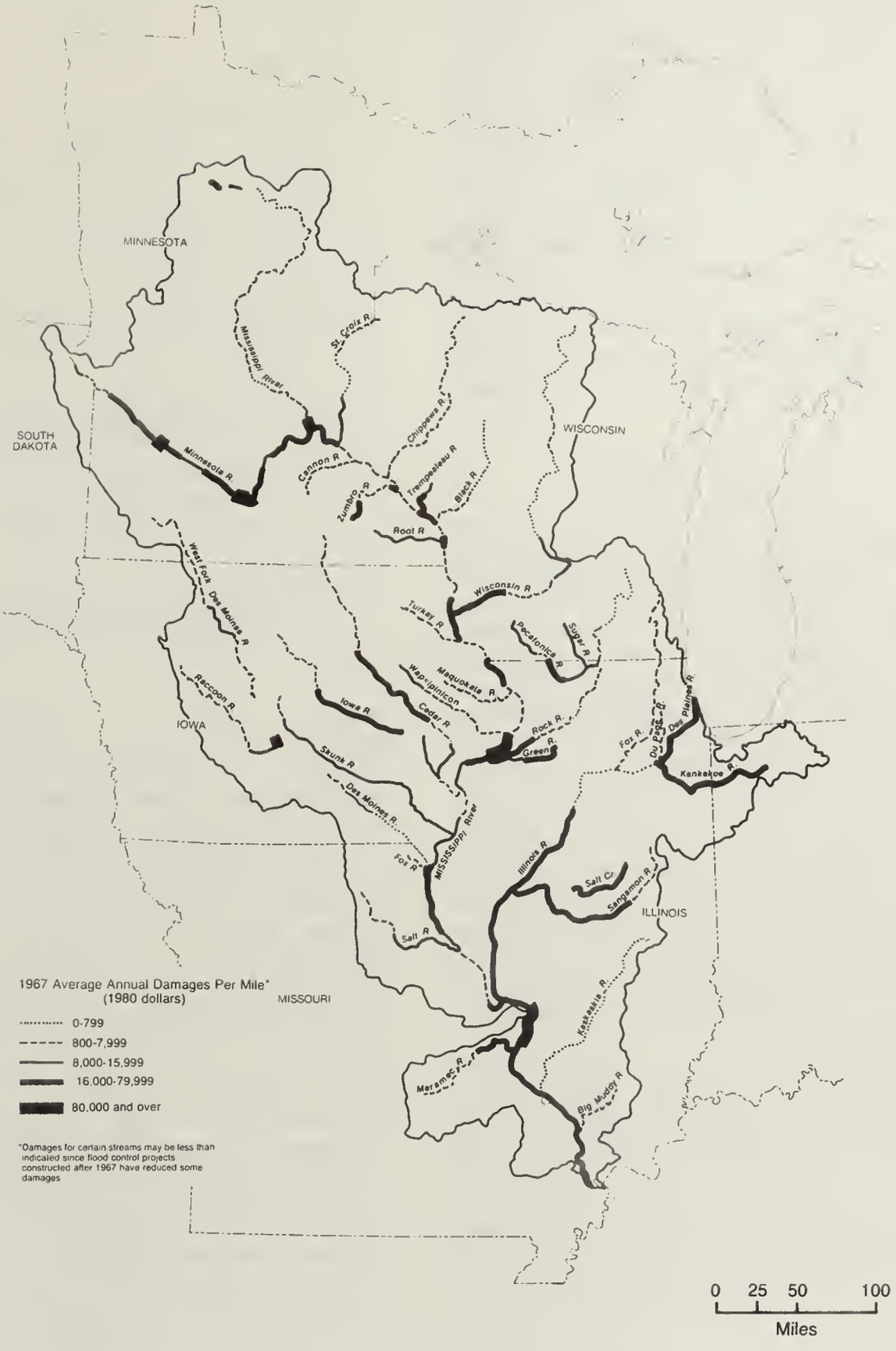

FIGURE II-16. AVERAGE ANNUAL FLOOD DAMAGES OF SELECTED STREAMS, UPPER MISSISSIPPI REGION

Source: UMRCBS Coordinating Committee, *Upper Mississippi River Comprehensive Basin Study,* (Vol. V), 1970.

mals, which are endangered by floodplain development. The floodplain is also valuable for its cultural resources. Areas of historical, archeological, scientific, recreational, aesthetic, and agricultural value are often found in floodplains.

Preservation of the region's floodplains is important for preventing increased susceptability to flooding, maintaining floodwater storage, and preserving the hydrologic, biotic, and cultural value of the floodplain. Although many municipalities and counties have adopted ordinances to regulate floodplain development, floodplain management programs need to be established throughout the region both to prevent additional flood-prone development and to preserve floodplain resources.

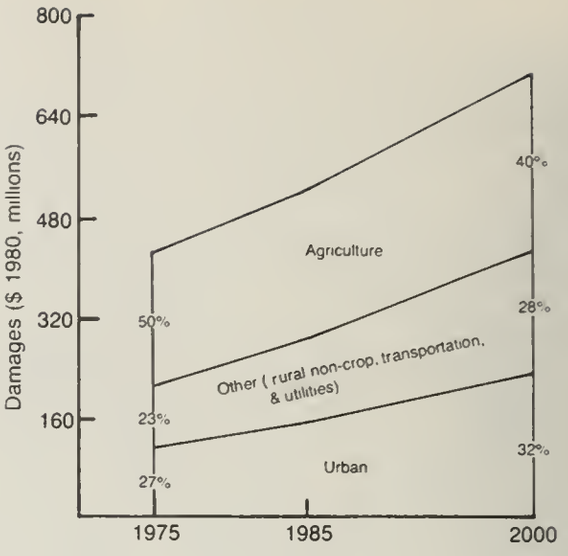

FIGURE II-17. AVERAGE ANNUAL FLOOD DAMAGES TO 2000*, UPPER MISSISSIPPI REGION

*Assumes new construction in most floodplains will be restricted through current floodplain management programs to minimize flood hazards, but improvements to structures and agricultural use of the floodplain will not be restricted.

Sources: UMRCBS Coordinating Committee, *Upper Mississippi River Comprehensive Basin Study*, (Vol. V), 1970.
U.S. Water Resources Council, *1975 National Water Assessment: Flood Damage Cost Methodology*, 1976.

Anticipated Problems

Programs regulating floodplain development will most likely continue to expand to cover most of the region's floodplain areas, except for some counties in Missouri.[38] However, regional damages will continue to rise because of the increasing value of existing development, transportation facilities, utilities, and agricultural land in the floodplain. Regional damages are projected to increase 67 percent by 2000, from $421 million to $702 million (Figure II-17). Inflation and further constriction of the floodplain by levees or urban encroachment would further increase damages. Implementation of additional flood damage reduction projects, however, or adoption of more stringent floodplain regulations would reduce the region's flood damages.

Under existing programs urban damages are projected to increase an estimated 102 percent from 1975 to 2000, from $111 million to $224 million annually. This projection assumes that additional floodplain development will be restricted by expanded floodplain regulations, but that damage to existing floodplain development will continue to rise. If the additional flood control projects currently proposed or under study are implemented in the future, the rise in urban damages will be curtailed further.

Rural non-crop damages and damage to transportation and utilities are also projected to increase an approximate 102 percent from 1975 to 2000 ($99 million to $200 million). Although floodproofing will be required in the future construction of transportation facilities and utilities, existing facilities within the floodplain will continue to be damaged. Rural non-crop damages will rise in the future as the value of structures and equipment in the floodplain rises.

Agricultural flood damages are projected to increase approximately 32 percent from 1975 to 2000, from an estimated $211 million to $278 million. This rate of increase would be lowered by implementation of the 66 Watershed Protection Projects (P.L. 566) proposed by the U.S. Department of Agriculture, Soil Conservation Service, and the agricultural levee improvements under study by the Army Corps of Engineers. However, since current floodplain management programs consider agriculture an acceptable use of

[38]Third and fourth class counties in Missouri, as defined by assessed valuation, are not authorized to adopt floodplain regulations unless they are located along the Mississippi River.

the floodplain, urban floodplain land may be converted to agricultural use in the future, which would further increase agricultural damages.

Governmental Authority, Responsibility, and Policy

Many federal and state agencies are authorized to implement flood damage reduction measures (Table II-22). In addition, two Presidential Executive Orders and a public law affect federal agency activities within the floodplain.

In May 1977, President Carter issued Executive Orders 11988 and 11990 requiring all federal agencies to minimize the degradation of floodplains and wetlands. These executive orders prohibit federal activities or federal assistance for activities that affect floodplains or wetlands unless there is no alternative. In cases where there is no practicable alternative, agencies proposing projects that affect the floodplain or wetlands must conduct a public review of the project and mitigate adverse effects.

Implementation of the executive orders is still incomplete. Executive Order 11988 directed the U.S. Water Resources Council and the Federal Emergency Management Agency to issue procedures for implementing the order and to monitor compliance. According to the procedures established by the Water Resources Council the 31 federal agencies affected by the order must adopt rules and regulations to ensure minimal effects on the floodplain. As of December 1979, only 19 agencies had published preliminary or final regulations. Of the 49 sub-agency units involved with floodplains, only 28 had published final or preliminary regulations.[39]

The December 1977 amendments to the Clean Water Act also affect floodplain activities. Section 404 of the act established a permit program for the discharge of dredged or fill material within navigable waters. Section 404 can affect flood control by regulating dam construction, channel diversion, and channelization projects; prohibiting dredged material disposal within state waters and wetlands; and regulating the filling of wetlands. The Army Corps of Engineers conducts the dredging permit program under Section 404. Section 404(t) requires federal compliance with state disposal regulatory programs.

The Army Corps of Engineers is the main federal agency involved with downstream flood protection projects and programs. Protection projects include structural projects or nonstructural measures such as floodproofing and relocation. Structural projects range from small channel clearing projects and local levees to large-scale dam and reservoir projects affecting larger areas (Figure II-18).

The U.S. Department of Agriculture, Soil Conservation Service (SCS) implements flood damage reduction projects in upstream areas. Most of the flood control benefits of SCS projects come from the small upstream impoundments and channel modification constructed under the small watershed projects (Watershed Protection and Flood Prevention Act, P.L. 83-566). Land treatment measures, also implemented through this program, improve water retention of the soil and thus have a minor additional effect on reducing flood stages.

For all structural projects implemented by these agencies, except large reservoirs, the local sponsors are required to absorb a portion of the costs. The local share of structural project costs include lands, easements, and rights-of-way; alterations and relocations of utilities, buildings, and transportation facilities, except railroad bridges; and project operation and maintenance. The local share of the cost for nonstructural projects is 20 percent of the total project cost including lands, easements, and rights-of-way.

Several changes to the existing cost-sharing arrangements have been proposed in the U.S. Congress. States would be required to contribute 5 percent of the costs of flood control projects within their borders as an incentive to participate in the planning and prioritization of projects. Local sponsors would be responsible for 20 percent of the costs for all flood control projects, structural and nonstructural, including lands, easements, and rights-of-way. The proposal applies only to projects not yet

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[39] Frank Thomas, U.S. Water Resources Council, Implementation of Executive Order 11988 Floodplain Management: Progress Report, 1 December 1979.

COMPLETED ARMY CORPS OF ENGINEERS FLOOD CONTROL PROJECTS (Numbers correspond to FIGURE II-18)

ILLINOIS

Rock River
- 22. De Kalb
- 23. Penny Slough D&LD*
- 24. Milan-Mill Creek

Little Calumet River
- 35. Little Calumet River Phase I

Illinois River
- 38. Hennepin D&LD
- 39. East Peoria D&LD
- 4D. Pekin & La Marsh D&LD
- 41. Rocky Ford D&LD
- 42. Spring Lake D&LD
- 43. Banner Special D&LD
- 44. East Liverpool D&LD
- 45. Liverpool D&LD
- 46. Lacy, Langellier, West Matanzas, Kerton Valley D&LD
- 47. Seahorn D&LD
- 48. Big Lake D&LD
- 49. Mouth of Sangamon River
- 54. Lost Creek D&LD
- 55. Sid Simpson
- 56. Coal Creek D&LD
- 57. Crane Creek D&LD
- 58. South Beardstown and Valley D&LD
- 59. New Pankey's Pond Special D&LD
- 6D. Little Creek D&LD
- 61. Meredosia Lake and Willow Creek D&LD
- 62. Willow Creek Drainage District
- 63. McGee Creek D&LD
- 64. Mauvaise Terre D&LD
- 65. Valley City D&LD
- 66. Scott County D&LD
- 67. Big Swan D&LD
- 68. Hillview D&LD
- 69. Hartwell D&LD
- 70. Keach D&LD
- 71. Eldred and Spankey D&LD
- 72. Nutwood D&LD

Sangamon River
- 5D. Mason and Menard D&LD
- 51. Dakford Special D&LD
- 52. Farmer's D&LD

Kaskaskia River
- 96. Dively D&LD
- 97. New Athens

*Drainage and Levee District

Mississippi River
- 15. Galena
- 17. Meredosia D&LD
- 25. Rock Island
- 28. Drury Drainage District
- 29. Bay Island D&LD
- 3D. Henderson County Drainage District No. 3
- 31. Henderson County Drainage District No. 1
- 32. Henderson County Drainage District No. 2
- 73. Hunt Drainage District
- 76. Lima Lake Drainage District
- 8D. Indian Grave Drainage District
- 81. South Quincy D&LD
- 84. Sny Island D&LD
- 89. Wood River D&LD
- 9D. Chouteau, Nameoki, Venice D&LD
- 91. Prairie DuPont Levee & Sanitary District
- 92. Columbia D&LD
- 93. Harrisonville and Ivy Landing D&LD
- 94. Stringtown-Ft. Chartres and Ivy Landing
- 95. Prairie Du Rocher and Vicinity
- 98. Kaskaskia Island D&LD
- 1DO. Degognia and Fountain Bluff D&LD
- 101. Grand Tower D&LD
- 1D2. Preston D&LD
- 103. Miller Pond Drainage District
- 104. Clear Creek D&LD
- 105. North Alexander D&LD
- 106. East Cape Girardeau and Clear Creek Drainage District

INDIANA

Kankakee River
- 36. Shelby
- 37. Sumava Resorts

IOWA

Upper Iowa River
- 10. Dry Run, Decorah
- 11. Upper Iowa River

Turkey River
- 12. Elkport

Mississippi River
- 13. Guttenberg
- 14. Dubuque
- 16. Sabula
- 26. Muscatine (Mad Creek)
- 27. Muscatine Island and Muscatine-Louisa County D&LD
- 33. Iowa River-Flint Creek D&LD
- 35. Green Bay D&LD

Iowa River
- 18. Marshalltown

Des Moines River
- 19. Des Moines
- 21. Dttumwa

Raccoon River
- 2D. Van Meter

MINNESOTA

Mississippi River
- 1. Aitkin Diversion
- 2. Elk River
- 3. St. Paul
- 4. South St. Paul

Vermillion River
- 5. Hastings

Minnesota River & Tributaries
- 6. Marshall
- 7. Redwood Falls

Zumbro River Lower Reach
- 8. Zumbro River Lower Reach

Root River
- 9. Root River at Rushford

MISSOURI

Mississippi River
- 74. Des Moines & Mississippi Levee District #1
- 75. Gregory Drainage District
- 77. Canton Local Protection
- 78. Union Township Drainage District
- 79. Fabius River Drainage District
- 82. Marion County Drainage District
- 83. South River Drainage District
- 85. Agricultural Area #12
- 86. Clarksville Project
- 87. Agricultural Area #10
- 88. Agricultural Area #8
- 99. Perry County D&LD 1,2,3
- 107. Cape Girardeau Local Protection

FIGURE II-18. COMPLETED ARMY CORPS OF ENGINEERS FLOOD CONTROL PROJECTS, UPPER MISSISSIPPI REGION

Sources: UMRBC, *FY 1983 Annual Priorities Report,* June 1981.
U.S. Army Corps of Engineers, *Water Resources Development in Illinois,* 1979; *Water Resources Development in Indiana,* 1979; *Water Resources Development in Iowa,* 1979; *Water Resources Development in Minnesota,* 1979; *Water Resources Development in Missouri,* 1979; *Water Resources Development in Wisconsin,* 1979.

FIGURE II-18. COMPLETED ARMY CORPS OF ENGINEERS FLOOD CONTROL PROJECTS, UPPER MISSISSIPPI REGION

Sources: UMRBC, *FY 1983 Annual Priorities Report,* June 1981.
U.S. Army Corps of Engineers, *Water Resources Development in Illinois,* 1979; *Water Resources Development in Indiana,* 1979; *Water Resources Development in Iowa,* 1979; *Water Resources Development in Minnesota,* 1979; *Water Resources Development in Missouri,* 1979; *Water Resources Development in Wisconsin,* 1979.

TABLE II-22. GOVERNMENTAL AUTHORITY AND RESPONSIBILITY FOR FLOOD DAMAGE REDUCTION, UPPER MISSISSIPPI REGION

Agency	Authority[a]		Primary Program (function)
		U.S. GOVERNMENT	
DEPARTMENT OF AGRICULTURE Agricultural Stabilization and Conservation Service	I	P.L. 95-334, Agricultural Credit Act of 1978 Title IV	Emergency Conservation Program (financial assistance to rehabilitate flooded land)
	I	Water Bank Act	Water Bank Program (payments to landowners for setting aside wetland acreage for wildlife habitat and floodwater storage)
	I	Agriculture and Consumer Protection Act of 1973	Forestry Incentives Program (cost sharing for timber stand improvement, can apply to floodplain hardwood stands)
Farmers Home Administration	I	Consolidated Farm and Rural Development Act (Sec. 3D6); P.L. 92-419; P.L. 95-334	Irrigation, Drainage, and Other Soil and Water Conservation Loans
	I	Consolidated Farm and Rural Development Act (Sec. 3D4); P.L. 92-419; P.L. 95-334	Recreation Facility Loans (for conversion of floodplain and other land into recreation facilities)
	I	Consolidated Farm and Rural Development Act (Sec. 3D4); P.L. 92-419; P.L. 95-334	Soil and Water Loans (loans for soil conservation measures and rural water supply development)
	I	Consolidated Farm and Rural Development Act (Sec. 306); P.L. 92-419; P.L. 95-334	Community Facilities Loans (for recreational facilities in floodplain areas)
	I	Food and Agriculture Act of 1962 P.L. 87-703)	Resource Development and Conservation Loans
	I	Watershed Protection and Flood Prevention Act (P.L. 83-566)	Watershed Protection and Flood Prevention Loans
Federal Crop Insurance Corporation	I	Federal Crop Insurance Act of 1938	Crop Insurance Program
Soil Conservation Service	I	Soil Conservation Act of 1935	Resource Conservation and Development Program (grants and technical assistance for water management)
	I	Watershed Protection and Flood Prevention Act (P.L. 83-566)	Watershed Protection and Flood Prevention Program (grants and technical assistance for planning and implementation of upstream flood reduction and watershed improvement works)
	I	Watershed Protection and Flood Prevention Act (Sec. 6) P.L. 83-566	River Basin Survey and investigations (flood hazard analysis for floodplain management programs)
DEPARTMENT OF THE ARMY Corps of Engineers	I	Flood Control Act of 1936 (P.L. 64-367)	(designs and constructs reservoirs, levees, and other flood control projects authorized by Congress)
	I	Flood Control Act of 1937 (Sec. 2); as amended (P.L. 79-14, 93-251)	Snagging and Clearing for Flood Control
	I	Flood Control Act of 1938 P.L. 75-761	(provides financial assistance for floodplain evacuation where costs for authorized flood control projects would be reduced)
	I	P.L. 84-99, Flood Control Act of 1941, as amended	Flood Fighting and Rescue Operations
	I	Flood Control Act of 1948 (Sec. 2D5); as amended	Small Flood Control Projects
	S	Flood Control Act of 1960 (Sec. 206); as amended	Floodplain Management Services
	S	P.L. 87-639, 1962	Joint Investigations (investigations with USDA of watersheds for flood prevention and the conservation and development of water resources)
	R	Water Pollution Control Act Amendments of 1972 (Sec. 404)	(issues permits for the discharge of dredged or fill material into navigable waters)
	S	National Dam Inspection Act of 1972 (P.L. 92-367)	Dam Safety Program (inventory and inspection of high hazard dams)
	I,S	Water Resources Development Act of 1974 (Sec. 22) P.L. 93-251	Planning Assistance to States
	S	Water Resources Development Act of 1974 (Sec. 73) P.L. 93-251	(considers nonstructural alternatives in flood control plan formulation)
DEPARTMENT OF COMMERCE National Oceanic and Atmospheric Administration	S	Reorganization Plan of 1970; Executive Order No. 11564	(gathers, processes, and issues information on different aspects of the land, ocean, and atmosphere)
Environmental Data Service	S	Reorganization Plan of 1970; Executive Order No. 11564	(information on flood stages, precipitation, snow cover, soil moisture, and other climatological events)
National Environmental Satellite Service	S	Reorganization Plan of 197D; Executive Order No. 11564	(satellite monitoring of meterological data, snow cover, and floods)
National Weather Service	S	Reorganization Plan of 197D; Executive Order No. 11564	(predicts flood events, issues flood warnings, assists communities in developing local warning systems and evacuation plans)
DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT	I	Housing and Community Development Act of 1974 (P.L. 93-383) as amended	Community Development Block Grants (flood and drainage facilities, open space acquisition, and relocation of floodprone structures)
	I	Housing and Community Development Act of 1974 (P.L. 93-383) as amended	Discretionary Disaster Program (provides floodproofing assistance after flood disasters)

TABLE II-22. (Continued)

Agency		Authority[a]	Primary Program (function)
DEPARTMENT OF THE INTERIOR			
Bureau of Reclamation	I	Small Reclamation Projects Act of 1956 (P.L. 84-984)	Small Reclamation Projects (loans and grants to public non-federal organization for flood control)
U.S. Geological Survey	S	Act of March 3, 1879	Water Resources Investigations (determines flood profiles and delineates floodplains)
Heritage Conservation and Recreation Service	I	Land and Water Conservation Fund Act of 1965 (P.L. 88-578)	Land and Water Conservation Fund (cost-sharing for open space acquisition)
Fish and Wildlife Service	I	Federal Aid in Wildlife Restoration Act of 1937	Pittman-Robertson Program for Wildlife Restoration (funding for state fish and game departments to purchase floodplain and other lands for wildlife habitat)
FEDERAL EMERGENCY MANAGEMENT AGENCY			
Federal Insurance Administration	I	Housing and Urban Development Act of 1968 (P.L. 90-448); Flood Disaster Protection Act of 1973 (P.L. 93-234)	National Flood Insurance Program
	I	Flood Disaster Protection Act of 1973, Section 1362	(funding for acquisition and floodproofing of flood-damaged structures)
	I	Disaster Relief Act of 1974 (P.L. 93-288	Disaster Assistance (for Presidentially-declared emergencies)
	I	Disaster Relief Act of 1974 (P.L. 93-288	State Disaster Preparedness Grants
SMALL BUSINESS ADMINISTRATION	I	Small Business Act (P.L. 85-536); Disaster Relief Act of 1970 (P.L. 91-606)	Physical Disaster Loans (funding for relocation of flood-damaged structures)
		ILLINOIS	
DEPARTMENT OF TRANSPORTATION			
Division of Water Resources	I	IL Statutes, Chapters 19 and 127	(plans, constructs, operates, and maintaines flood control and drainage projects, provides emergency flood relief)
	R,S	IL Statutes, Chapters 19 and 127	(issues permits for construction in the floodplain and in public waters, defines boundaries of floodplains, coordinate for National Flood Insurance Program)
	S	IL Statutes, Chapters 19 and 127	Dam Safety Program
Water Resources Commission	S	IL Statutes, Chapter 19	(studies the effectiveness of government programs for flood control)
		IOWA	
EXECUTIVE COUNCIL	I	IA Statutes, Chapters 19 and 469A	(flood disaster aid)
IOWA GEOLOGICAL SURVEY	S	IA Statutes, Chapter 305	(cooperator for floodstage studies)
IOWA NATURAL RESOURCES COUNCIL	R,S,I	IA Statutes, Chapter 455A	(regulates construction, excavation, or dredging on all floodways, coordinates National Flood Insurance Program, establishes statewide comprehensive flood control programs)
	S	IA Statutes, Chapter 455A	Dam Safety Program
		MINNESOTA	
DEPARTMENT OF NATURAL RESOURCES	R	MN Statutes, Chapters 104,105	(administers State Floodplain and Shoreland Management Programs)
	R	S.R. 2051	(issues permits for disposal of dredged materials below the ordinary high water mark)
	S,E	MN Statutes, Chapter 105, Sec. 38, 52, 53	Dam Safety Program
DEPARTMENT OF PUBLIC SAFETY Division of Emergency Services	I	MN Statutes, Chapter 12	(flood disaster assistance)
SOIL AND WATER CONSERVATION BOARD	I	MN Statutes, Chapter 40	(administers pilot program for small reservoir construction)
SOUTHERN MINNESOTA RIVERS BASIN BOARD	S,I	MN Statutes, Chapters 114A.01-114A.09	(assists local units of government as they develop flood control programs in the Southern Minnesota Rivers Basin)
		MISSOURI	
DEPARTMENT OF PUBLIC SAFETY	I	Omnibus Reorganization Act of 1974	(flood disaster assistance)
DEPARTMENT OF NATURAL RESOURCES	S	Omnibus Reorganization Act of 1974	Dam Safety Program

TABLE II-22. (Continued)

Agency		Authority[a]	Primary Program (function)
	R,I	Governor's Executive Order on Floodplain Management	(coordinates National Flood Insurance Program activities, regulates construction of state owned buildings in the floodplain)
	E	Water Pollution Control Act Amendments of 1972 (Section 404)	(review of dredge and fill permit requests)
	R	MO Revised Statutes 49.600249.615	(enables county courts in second, third, and fourth class counties along the Mississippi River to participate in the National Flood Insurance Program)
		SOUTH DAKOTA	
STATE PLANNING BUREAU	S	SD Compiled Law 11-45	(coordinates National Flood Insurance Program within the state, assists communities in establishing floodplain management programs)
		WISCONSIN	
DEPARTMENT OF DEVELOPMENT	S	WI Statutes, Chapter 560	(coordinates state planning efforts for flood prevention and other economic issues)
DEPARTMENT OF LOCAL AFFAIRS IN DEVELOPMENT	S,I	WI Statutes, Chapter 22	(flood disaster assistance)
DEPARTMENT OF NATURAL RESOURCES	I	WI Statutes, Chapter 31	Dam Safety Program
	S,I	WI Statutes, Chapter 15	(implements structural and nonstructural flood control measures)
	R	WI Statutes, Chapter 30	(prohibits disposal of materials within navigable waters)
	S,R	WI Statutes, Chapter 87.30	(requires counties and incorporated municipalities to adopt floodplain and shoreland management ordinances when flood data is available, formulates ordinances when local government fails to act; prohibits placement of fill in floodways)

[a]Scope of authority is defined as follows:
S= Statutory: research, collect information, coordinate, prepare plans
R= Regulatory: establish rules and regulations, issue permits
E= Enforcement: enforce laws and regulations
I= Implementation/Construction: administer funds, acquire land, construct and operate projects

Sources: Executive Office of the President, Office of Management and Budget, 1979 Catalog of Federal Domestic Assistance, May 1979.
U.S. Department of the Army, Corps of Engineers, Digest of Water Resources Policies and Authorities, September 1979.
Upper Mississippi River Basin Commission, FY 1978 Program Report of State and Federal Water and Related Land Resources Efforts, December 1978.
Upper Mississippi River Basin Commission, Upper Mississippi River Main Stem Level B Study, Technical Paper G: Legal and Institutional, August 1979. (draft)

authorized and are currently under consideration in Congress.

In addition to the Army Corps of Engineers and SCS programs, several federal financial aid programs directly address flood damage reduction. Two such programs are the National Flood Insurance Program, administered by the Federal Insurance Administration (FIA), and the Federal Crop Insurance Program, administered by the U.S. Department of Agriculture.

The FIA is responsible for the development and coordination of floodplain management programs to reduce future flood damages. FIA works with state agencies in designing floodplain management programs and encouraging local agencies to establish floodplain regulations. Under the National Flood Insurance Act of 1973, the FIA provides subsidized flood insurance to municipalities who have passed adequate floodplain management ordinances. Through the Floodplain Mapping and Flood Profile Information Programs, the FIA identifies flood-prone areas and delineates floodplain boundaries. Communities that are identified as flood-prone must apply for the program within a year from identification and agree to adopt floodplain regulations. If a community does not participate in the program, it is denied flood insurance, flood disaster assistance, and other types of federal financial assistance in floodplain areas.

Where relocation of residents is more cost-effective than repairing the flood damaged structures, the FIA is authorized to provide financial assistance.[40] Structures severely damaged can be purchased at market value by the FIA and the land turned over to the local government for conversion to open space. This

[40]Authorized by Section 1362 of the 1973 National Flood Insurance Act.

program was initiated in FY 1980 and funded at $5.4 million. Section 1362 also authorized assistance for elevating flood-prone structures. This program has not yet been initiated.

The Constructive Total Loss condition of the National Flood Insurance Program is another opportunity for relocation assistance established by the FIA. This condition allows the policyholder to claim the entire amount of coverage for relocation or evacuation when flood losses are extensive. Another condition of the program allows landowners, when structures are not substantially damaged, to claim up to the policy limit for elevation and floodproofing.

The Department of Housing and Urban Development (HUD) provides financial assistance for relocation and floodproofing through two programs. The HUD Block Grant Program provides land acquisition and relocation funds for flood-prone areas. After flood disasters, communities can also apply for funds under the Discretionary Disaster Program to restore housing and to elevate and floodproof structures. Although funded at $100 million in 1980, the program was not included in the 1981 budget.

The U.S. Department of Agriculture, Federal Crop Insurance Corporation, alleviates some of the economic burden resulting from agricultural flooding. Insured property is guaranteed a certain yield depending on the productivity of the land. When natural hazards reduce crop yields, the difference between the actual and guaranteed yields is paid in benefits. However, guaranteed yields on floodplain land are lower than for upland areas because average productivity is lower. Thus, landowners with frequent flood problems do not benefit significantly from the program. Federal legislation has been enacted recently to subsidize the program, which would increase coverage to moderately flood-prone areas.[41] Frequently flooded areas (inundated once every two years or more) are not covered by the program. Another limitation of the program is that expansion is restricted to 150 counties per year nationally.

All of the states in the region have floodplain management programs which assist municipalities in establishing regulations and coordinate the activities of the National Flood Insurance Program. Municipalities and counties in Minnesota and Wisconsin are required to adopt floodplain zoning ordinances after the floodplain is delineated by the state or federal government. The Minnesota and Wisconsin Departments of Natural Resources (Mn DNR, Wis DNR) must formulate floodplain regulations if the local government does not enact adequate ordinances. The Wis DNR regulations prohibit any development on the floodway or floodway fringe that will increase the height of the regional flood by 0.1 feet or more. Communities in both states are permitted to establish regulations more stringent than state standards.[42]

Municipalities and counties in Iowa have the authority to enact floodplain ordinances and submit plans for approval to the Iowa Natural Resources Council (INRC). The INRC regulates floodplain development where local governments have not enacted ordinances.

Municipalities in Illinois are authorized to enact floodplain regulations. The Illinois Department of Transportation (IDOT) restricts any placement of materials in the floodplain that would impair floodwater storage. Activities that singly or cumulatively increase flood stage or velocity significantly are usually prohibited, which includes most activities in the floodway. In the floodway fringe a wider range of activities is allowed.

Before April, 1980, only first and second class counties in Missouri (defined by assessed valuation) were authorized to pass floodplain regulations without referendum. Legislation passed by the 1980 General Assembly enables third and fourth-class counties located on the Mississippi River to adopt floodplain management ordinances. Third and fourth-class counties not adjacent to the Mississippi River are still unable to pass floodplain regulations without

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[41]Senate Bill 1125 and House Report 4119.

[42]Great River Environmental Action Team, State and Federal Restrictions on Dredge Spoil Placement in the Upper Mississippi River Area, by Suzan M. Stewart for the Dredged Material Uses Work Group, May 1978.

referendum.

All of the states in the region have enacted dam safety legislation and are cooperating with the Army Corps of Engineers in the inventory and inspection of nonfederal dams, as authorized by the National Dam Inspection Act. The objectives of this Act are to inventory dams in the United States and develop recommendations for a comprehensive National Dam Safety Program. Approximately 8000 high-hazard nonfederal dams (approximately 20 percent of all nonfederal dams) in the United States will be inspected over a four-year period. High-hazard dams are those situated closely upstream from populated and developed areas and whose failure would cause substantial loss of life and property downstream. The Army Corps of Engineers began the inspection in December 1977 and began training state personnel to continue the inspection after completion of the federal inspection program in 1981. States with Dam Safety Programs will continue periodic inspections after 1981.

Alternative Solutions and Effects

The major types of flood damages are summarized as follows.

(1) Agricultural damage. Floods cause the largest financial losses in agricultural areas. Average annual agricultural damages are estimated at $421 million. The largest agricultural damages occur in the Lower Illinois River Basin.

(2) Urban damage. The region's urban damages average an estimated $111 million per year, comprising 26 percent of the regional damages. Disruption of communities and loss of lives are also consequences of urban flooding. The most severe urban damages occur in the Kaskaskia-Meramec River Basin.

(3) Other damages. Other damages are estimated at $99 million and constitute 24 percent of the region's average annual damage. Included are rural non-crop losses and damage to transportation facilities and utilities.

Numerous structural and nonstructural measures are available to reduce urban and rural flood damages (Table II-23). Structural measures are those that modify flood behavior and include channel modifications, levees, floodwalls, diversion channels, and reservoirs. Nonstructural measures include most other measures and are defined as "adjustments in floodplain occupance not specifically intended to modify flood behavior."[43] Many nonstructural measures, however, such as relocation or floodproofing may actually involve construction.

The economic feasibility and local acceptability of different flood reduction measures vary from one site to another. The severity and type of flooding and the economic and social feasibility of alternative measures in a particular site will determine the most appropriate solution or combination of solutions for the site involved.

Structural and nonstructural measures can be used either to reduce damage to existing development (corrective) or to prevent future damages (preventive). Structural measures have been used in the past as both a corrective and preventive approach. It has been recognized in recent years, though, that nonstructural measures such as regulations are less costly in preventing damages. Floodplain regulations have been used throughout much of the region to prevent the development of flood-prone structures. However, nonstructural measures such as relocation and floodproofing have not played a large role as a corrective measure because their economic and social feasibility have not been thoroughly investigated.

Several communities within the region have found nonstructural measures to be feasible as a corrective measure instead of the traditional structural approach. Local agencies in St. Louis County, Missouri, are acquiring structures and parcels of land along the Meramec River for an open space corridor, funded through a $2 million bond. Another example is Soldiers Grove, Wisconsin, which experiences extensive flooding from the Kickapoo River. With the Department of Housing and Urban Development pro-

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[43]U.S. Water Resources Council, A Unified National Program for Floodplain Management, September 1979.

TABLE II-23 ALTERNATIVE SOLUTIONS TO FLOODING: ANALYSIS AND EVALUATION[a], UPPER MISSISSIPPI REGION

Alternative Solution (Problem Addressed)	Four Account Effects				Evaluation			Conclusion
	NED	EQ	RED	OSE	Planning Objective	Efficiency	Acceptability	
(1) Increase acquisition and relocation of flood-prone structures (Urban damage; Other damages)	- national cost + agricultural output + reduced disaster assistance	+ fish & wildlife habitat + natural areas + surface water quality + sediment control	+ economic stability - local cost + flood damage reduction	+ real income + health & safety + recreation + emergency preparation - displacement of home/people	NED,EQ, NS	High	Medium	Conditionally Recommended
(2) Increase floodproofing of structures in floodplain areas (Urban damage; Other damages)	- national cost + industrial output + commercial output + reduced disaster assistance	xx	+ economic stability - local cost + flood damage reduction	+ real income + health & safety + emergency preparation	NED,NS	Medium	High	Conditionally Recommended
(3) Construct additional levees and channel modification projects to protect urban development (Urban damages)	- national cost + non-agricultural output + reduced disaster assistance	- fish & wildlife habitat - natural areas - erosion control - sediment control	+ jobs + economic stability + flood damage reduction - local cost	+ real income + health & safety + emergency preparation - aesthetics	NED	Medium	High	Conditionally Recommended
(4) Construct additional downstream dams and reservoirs to protect flood-prone development (Urban damage; Other damages; Agricultural damage)	- national cost - agricultural output + non-agricultural output + reduced disaster assistance	- natural areas - sediment control + instream flows - surface water quality	+ jobs + population distribution + water supply + flood damage reduction - local cost	+ real income + health & safety + emergency preparation - displacement of homes/people	NED	Low	Medium	Not Recommended
(5) Accelerate regulation of floodplains to prevent development of flood-prone structures (Urban damage; Other damages)	- national cost + agricultural output + reduced disaster assistance + non-agricultural output	+ fish & wildlife habitat + natural areas + surface water quality + sediment control	+ flood damage reduction - local cost	+ health & safety + recreation + aesthetics	NED,EQ, NS	High	High	Recommended
(6) Protect agricultural or undeveloped floodplains with levees (Agricultural damage)	- national cost + agricultural output + non-agricultural output	+ fish & wildlife habitat - natural areas	+ jobs + population distribution - local cost	+ real income - recreation - aesthetics - health & safety	NED	Medium	Medium	Conditionally Recommended
(7) Design emergency flood fighting and evacuation plans and increase participation in local flash flood warning systems (Urban damage)	- national cost + non-agricultural output + reduced disaster assistance	xx	- local cost + flood damage reduction + economic stability	+ real income + health & safety + emergency preparation	NED,NS	High	High	Recommended
(8) Convert frequently flooded agricultural land to other uses compatible with the floodplain (Agricultural damage)	- agricultural output + service output	+ fish & wildlife habitat + natural areas + surface water quality + sediment control	- local cost + flood damage reduction	+ real income + recreation	EQ,NS	High	Medium	Conditionally Recommended
(9) Encourage the use of water-tolerant plants in flood-prone agricultural land (Agricultural damage)	- federal cost + agricultural output	xx	+ flood damage reduction	+ real income	NED,NS	Medium	Medium	Study
(10) Provide small upstream reservoirs for floodwater storage to reduce agricultural flood damages (Agricultural damage; Other damages)	- national cost + agricultural output	- fish & wildlife habitat - natural areas - sediment control + instream flows	+ jobs - local cost + flood damage reduction - state cost	+ real income + emergency preparation	NED	Medium	Medium	Conditionally Recommended
(11) Curb rising flood stages by restricting cropland drainage, wetland alterations, and floodplain development (Urban damage; Agricultural damage; Other damages)	- national cost + non-agricultural output - agricultural output	+ fish & wildlife habitat + natural areas + sediment control + surface water quality + instream flows	+ economic stability + flood damage reduction - local cost	+ real income + health & safety + recreation + emergency preparation + aesthetics	NED,EQ, NS	High	High	Recommended
(12) Restore drained wetlands to provide floodwater storage and reduce flood peaks (Urban damage; Other damages; Agricultural damage)	- national cost + reduced disaster assistance + non-agricultural output	+ erosion control + sediment control + fish & wildlife habitat + surface water quality + instream flows	+ flood damage reduction - local cost	+ recreation + health & safety	NED,EQ	Medium	Medium	Study
(13) Adopt stormwater management regulations to prevent increasing flood stages (Urban damage; Other damages; Agricultural damage)	- national cost + non-agricultural output + agricultural output + reduced disaster assistance	+ sediment control + erosion control + instream flows	+ flood damage reduction - local costs - state costs	+ emergency preparation + health & safety	NED	High	High	Recommended

TABLE II-23. (Continued)

Alternative Solution (Problem Addressed)	Four Account Effects				Evaluation			Conclusion
	NEO	EQ	REO	OSE	Planning Objective	Efficiency	Acceptability	
(14) Make federal and nonfederal cost-sharing formulas for structural and nonstructural measures equal (Urban damage)	+ national cost	+ fish & wildlife habitat + natural areas	- state cost - local cost + flood damage reduction	xx	EQ,NS	High	High	Recommended
(15) No action	- non-agricultural output - agricultural output - reduced disaster assistance	- fish & wildlife habitat - natural areas - erosion control - surface water quality	- economic stability - flood damage reduction	- real income - health & safety - emergency preparation	-	Low	Low	Not Recommended

[a]Abbreviations in the Table: NED (National Economic Development), EQ (Environmental Quality), REO (Regional Economic Development), OSE (Other Social Effects), NS (Nonstructural), XX (Not applicable)

For complete definition of Effects, Planning Objectives, Efficiency, Acceptablility, and Conclusions see Appendix E.

viding partial funding, 44 businesses and 50 residences will be purchased, the structures rebuilt off the floodplain, and the former site turned into a park. The Army Corps of Engineers is implementing another relocation project at Prairie du Chien, Wisconsin. The plan involves relocation or acquisition of 130 structures and floodproofing assistance for approximately 175 structures at a cost of $4,250,000 (1978 estimate). In Austin, Minnesota, 78 homes are being acquired and relocated through a Department of Housing and Development (HUD) Community Block Grant.

Although relocation can be effective in reducing the risk of flood damage, it is in some cases unacceptable because rebuilding disrupts the social and physical environment. However, the additional riverside recreation areas, open space, and wildlife habitat created through relocation provide benefits in addition to flood damage reduction.

Floodproofing is another corrective nonstructural alternative and involves the protection of structures with ring dikes, wall reinforcement, water-tight doors, and increased structural elevation. Moving essential equipment to upper floors and using the ground floor for parking or other nonessential uses can also be effective. Although structural damage is minimized by floodproofing, disruption of business and loss of housing continue to be a problem. Floodproofing is most effective in areas with infrequent flooding, since use of floodproofed buildings is restricted during floods. However, extensive damages have been prevented by floodproofing industrial development in the frequently flooded Mississippi River floodplain near St. Louis, Missouri.

Structural flood reduction measures are most appropriate for densely developed floodplains since benefits are more likely to exceed costs in such areas. Levees, floodwalls, and channel modification all prevent floodwaters from entering the floodplain. These measures, however, can increase flood stages by constricting flows or increasing flow velocity. Reservoirs can temporarily retain floodwaters but their effect dissipates as downstream tributary flow enters the river. Most of the structural flood control projects proposed or underway in the region are new levees or enlargements of existing levees (Figures II-19 and II-20).

Depending on the site involved, structural measures cause varying degrees of damage to riparian vegetation, fish and wildlife habitat, and scenic and recreational values. In addition, reservoirs create permanent changes in the character of the stream which can affect recreation and fish and wildlife habitat. Reservoirs can be constructed and operated, however, to recreate wetlands and thus have a beneficial effect on fish and wildlife. An alternative to dam-reservoir projects are dry dams which impound water only during high water. Land is required for these projects only temporarily and adverse fish and wildlife effects are less extensive.

Flood warning systems and emergency flood fighting plans can save lives and reduce the cost of flooding. Communities can prepare for flash flooding through

FIGURE II-19. FLOOD CONTROL PROJECT IMPLEMENTATION*, UPPER MISSISSIPPI REGION

*All projects are constructed or proposed by the U.S. Army, Corps of Engineers except St. Louis County, Soldiers Grove, and Wood River, which are local or state funded projects.

Sources: U.S. Army Corps of Engineers, *1979 Annual Report of the Chief of Engineers on Civil Works Activities, (Vol. II) 1979.*

U.S. Army Corps of Engineers, Water Resources Development in Illinois, 1979; *Water Resources Development in Indiana,* 1979; *Water Resources Development in Iowa,* 1979; *Water Resources Development in Missouri,* 1979; *Water Resources Development in Wisconsin,* 1979.

UMRBC, *FY 1983 Annual Priorities Report,* June 1981.

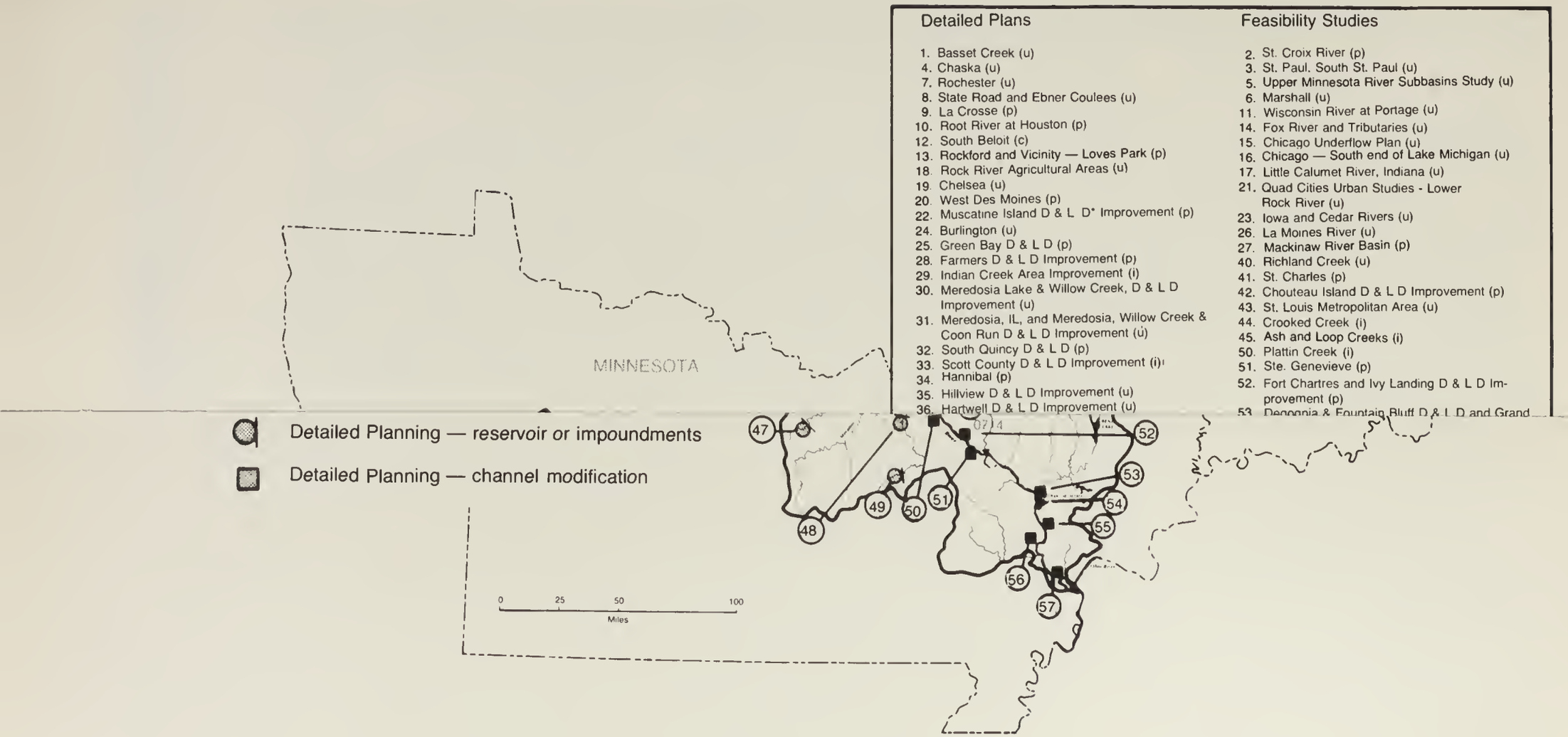

Detailed Plans
1. Basset Creek (u)
4. Chaska (u)
7. Rochester (u)
8. State Road and Ebner Coulees (u)
9. La Crosse (p)
10. Root River at Houston (p)
12. South Beloit (c)
13. Rockford and Vicinity — Loves Park (p)
18. Rock River Agricultural Areas (u)
19. Chelsea (u)
20. West Des Moines (p)
22. Muscatine Island D & L D* Improvement (p)
24. Burlington (u)
25. Green Bay D & L D (p)
28. Farmers D & L D Improvement (p)
29. Indian Creek Area Improvement (i)
30. Meredosia Lake & Willow Creek, D & L D Improvement (u)
31. Meredosia, IL, and Meredosia, Willow Creek & Coon Run D & L D Improvement (u)
32. South Quincy D & L D (p)
33. Scott County D & L D Improvement (i)
34. Hannibal (p)
35. Hillview D & L D Improvement (u)
36. Hartwell D & L D Improvement (u)
Feasibility Studies
2. St. Croix River (p)
3. St. Paul, South St. Paul (u)
5. Upper Minnesota River Subbasins Study (u)
6. Marshall (u)
11. Wisconsin River at Portage (u)
14. Fox River and Tributaries (u)
15. Chicago Underflow Plan (u)
16. Chicago — South end of Lake Michigan (u)
17. Little Calumet River, Indiana (u)
21. Quad Cities Urban Studies - Lower Rock River (u)
23. Iowa and Cedar Rivers (u)
26. La Moines River (u)
27. Mackinaw River Basin (p)
40. Richland Creek (u)
41. St. Charles (p)
42. Chouteau Island D & L D Improvement (p)
43. St. Louis Metropolitan Area (u)
44. Crooked Creek (i)
45. Ash and Loop Creeks (i)
50. Plattin Creek (i)
51. Ste. Genevieve (p)
52. Fort Chartres and Ivy Landing D & L D Improvement (p)
MINNESOTA
Detailed Planning — reservoir or impoundments
Detailed Planning — channel modification
0 25 50 100
Miles

FIGURE II-20. FLOOD CONTROL STUDIES, UPPER MISSISSIPPI REGION

Sources: U.S. Army Corps of Engineers, *1979 Annual Report of the Chief of Engineers on Civil Works Activities*, (Vol. II) 1979.
U.S. Army Corps of Engineers, *Water Resources Development in Illinois*, 1979; *Water Resources Development in Indiana*, 1979; *Water Resources Development in Iowa*, 1979; *Water Resources Development in Minnesota*, 1979; *Water Resources Development in Missouri*, 1979.
UMRBC, *FY 1983 Annual Priorities Report*, January 1981.

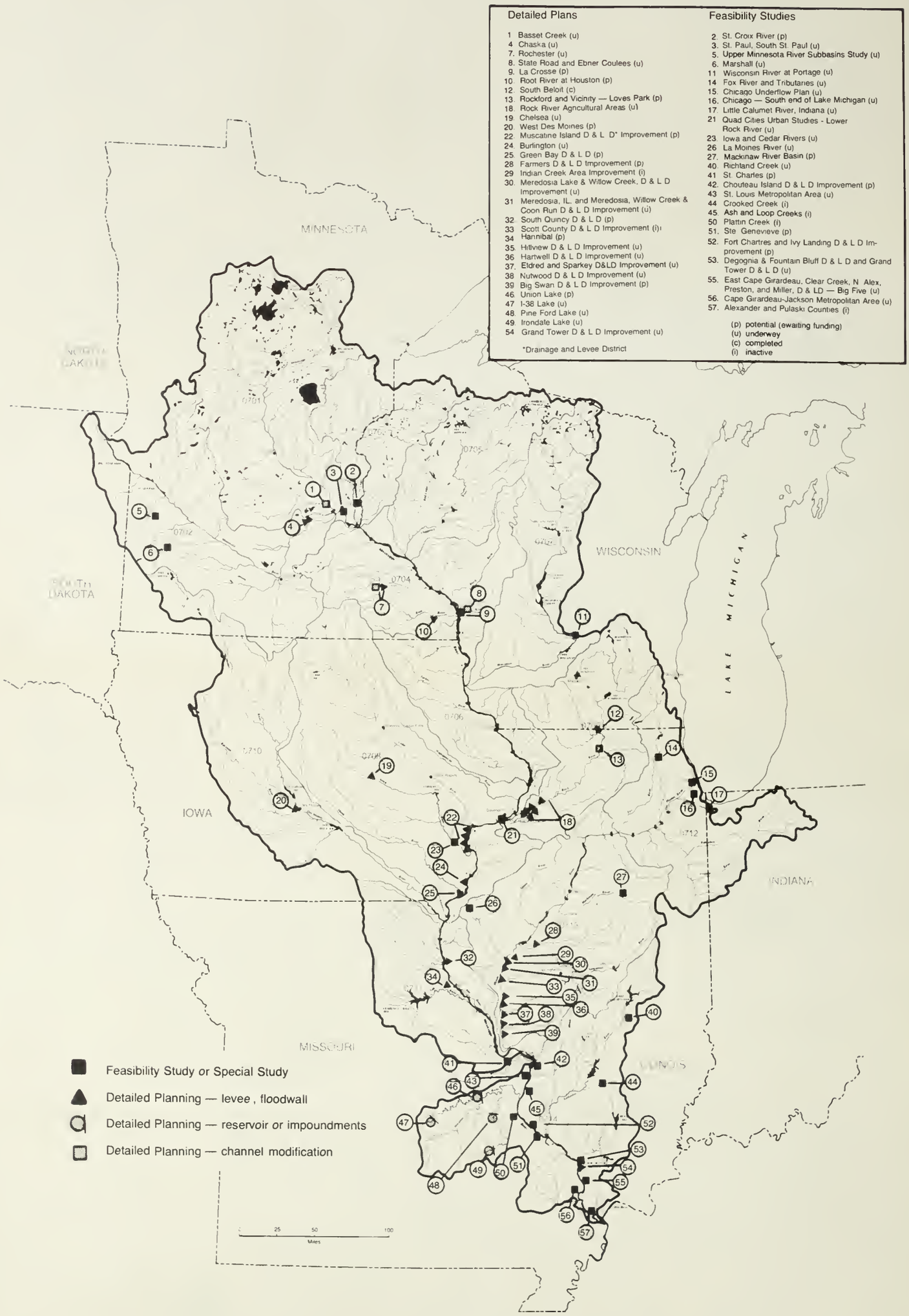

Detailed Plans
1 Basset Creek (u)
4 Chaska (u)
7. Rochester (u)
8. State Road and Ebner Coulees (u)
9. La Crosse (p)
10. Root River at Houston (p)
12. South Beloit (c)
13. Rockford and Vicinity — Loves Park (p)
18. Rock River Agricultural Areas (u)
19. Chelsea (u)
20. West Des Moines (p)
22. Muscatine Island D & L D* Improvement (p)
24. Burlington (u)
25. Green Bay D & L D (p)
28. Farmers D & L D Improvement (p)
29. Indian Creek Area Improvement (i)
30. Meredosia Lake & Willow Creek, D & L D Improvement (u)
31. Meredosia, IL. and Meredosia, Willow Creek & Coon Run D & L D Improvement (u)
32. South Quincy D & L D (p)
33. Scott County D & L D Improvement (i)
34. Hannibal (p)
35. Hillview D & L D Improvement (u)
36. Hartwell D & L D Improvement (u)
37. Eldred and Sparkey D&LD Improvement (u)
38. Nutwood D & L D Improvement (u)
39. Big Swan D & L D Improvement (p)
46. Union Lake (p)
47. I-38 Lake (u)
48. Pine Ford Lake (u)
49. Irondale Lake (u)
54. Grand Tower D & L D Improvement (u)
*Drainage and Levee District
Feasibility Studies
2. St. Croix River (p)
3. St. Paul, South St. Paul (u)
5. Upper Minnesota River Subbasins Study (u)
6. Marshall (u)
11. Wisconsin River at Portage (u)
14. Fox River and Tributaries (u)
15. Chicago Underflow Plan (u)
16. Chicago — South end of Lake Michigan (u)
17. Little Calumet River, Indiana (u)
21. Quad Cities Urban Studies - Lower Rock River (u)
23. Iowa and Cedar Rivers (u)
26. La Moines River (u)
27. Mackinaw River Basin (p)
40. Richland Creek (u)
41. St. Charles (p)
42. Chouteau Island D & L D Improvement (p)
43. St. Louis Metropolitan Area (u)
44. Crooked Creek (i)
45. Ash and Loop Creeks (i)
50. Plattin Creek (i)
51. Ste. Genevieve (p)
52. Fort Chartres and Ivy Landing D & L D Improvement (p)
53. Degognia & Fountain Bluff D & L D and Grand Tower D & L D (u)
55. East Cape Girardeau, Clear Creek, N. Alex, Preston, and Miller, D & LD — Big Five (u)
56. Cape Girardeau-Jackson Metropolitan Aree (u)
57. Alexander and Pulaski Counties (i)
(p) potential (awaiting funding)
(u) underwey
(c) completed
(i) inactive
MINNESOTA
WISCONSIN
LAKE MICHIGAN
IOWA
INDIANA
MISSOURI
ILLINOIS
0701
0704
0705
0706
0710
0712
Feasibility Study or Special Study
Detailed Planning — levee, floodwall
Detailed Planning — reservoir or impoundments
Detailed Planning — channel modification
25
50
100
Miles

FIGURE II-20. FLOOD CONTROL STUDIES, UPPER MISSISSIPPI REGION

Sources: U.S. Army Corps of Engineers, *1979 Annual Report of the Chief of Engineers on Civil Works Activities,* (Vol. II) 1979.
U.S. Army Corps of Engineers, *Water Resources Development in Illinois,* 1979; *Water Resources Development in Indiana,* 1979; *Water Resources Development in Iowa,* 1979; *Water Resources Development in Minnesota,* 1979; *Water Resources Development in Missouri,* 1979.
UMRBC, *FY 1983 Annual Priorities Report,* January 1981.

several alternatives. A Local Flash Flood Warning System can be developed with assistance by the National Weather Service (NWS). The NWS trains a local representative to interpret weather data and issue local warnings. Another alternative is the NWS Flash Flood Alarm Systems which use an electronic sensor to monitor flood stages and issue warnings to a local representative. The NWS has installed alarm systems on an experimental basis in Whitewater, Minnesota, and Chicago, Illinois.

Areas without these local systems are protected by NWS flash flood warnings and watches via media broadcasts, the Defense and Civil Preparedness Agency's interstate telephone system (National Warning System), or the National Oceanic and Atmospheric Administration's Weather Radio broadcasts. However, the effectiveness of all these methods are dependent on adequate evacuation plans and communication systems within the community. Of the 270 communities with flash flood hazards only 31 have developed warning and evacuation plans.

The measures listed above all protect existing urban development from flooding, but can be costly and often have adverse effects on the human or physical environment. The nationwide cost for Army Corps of Engineers and Soil Conservation Service flood control programs averaged $600 million per year from 1965 to 1974.[44] However, many of the structural flood control projects implemented through these programs have led to a false sense of security resulting in increased development on the floodplain. Subsequently, project failure or floods greater than the design flood have caused additional damages. Enlargement of levee projects became necessary as flood stages rose and development expanded outside project boundaries. In the 1960's this costly cycle was recognized and the National Flood Insurance Program was initiated. Through this program most floodplains in the region are regulated to minimize development of structures vulnerable to flood damage and to prevent the needs for additional corrective measures.

Participation in the National Flood Insurance Program and adoption of adequate floodplain regulations by all flood-prone communities in the region would curb the increasing urban flood damages. Floodplain regulations include the use of zoning ordinances, building codes, and subdivision regulations either to restrict use of the floodplain or to require floodproofing of new structures. Acquisition of undeveloped floodplain land by local, state, or federal agencies also prevents development. Preventing floodplain development through regulations or acquisition has the additional benefit of preserving the hydrologic, biotic, and cultural values of the floodplain.

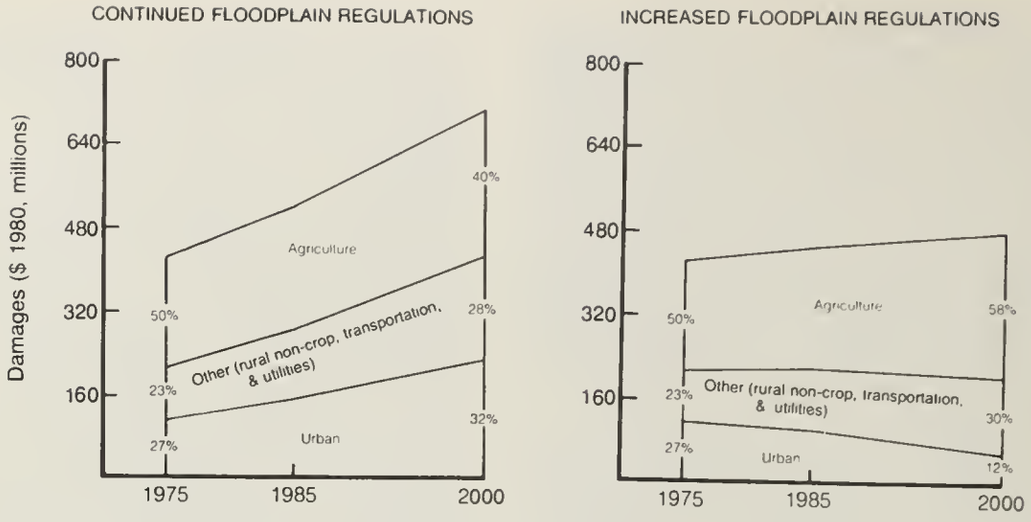
Two alternative scenarios based on different levels of floodplain management were prepared to evaluate the effectiveness of floodplain regulations in reducing flood damages (Figure II-21, Table II-24). If the use of floodplain regulations is continued to restrict new construction, damages would increase 67 percent from $421 million to an estimated $702 million, because damage to agricultural and existing urban damages would continue. If all floodplains are regulated and the degree of regulation is increased to prohibit new construction and restrict improvements to existing structures, total damages would increase 27 percent from $421 million to an estimated $536 million. Under this alternative urban damages would decrease 48 percent, and agricultural and rural non-crop damages would constitute 89

TABLE II-24. AVERAGE ANNUAL FLOOD DAMAGES UNDER ALTERNATIVE LEVELS OF FLOODPLAIN REGULATION, UPPER MISSISSIPPI REGION

	Continued Regulation of Floodplains			Increased Floodplain Regulation		
	1975	1985	2000	1975	1985	2000
	(millions of 1980 dollars)					
Downstream Flood Damages	208	265	379	208	222	232
Upstream Flood Damages	213	250	323	213	245	304
TOTAL	421	515	702	421	467	536

Sources: UMRCBS Coordinating Committee, Upper Mississippi River Comprehensive Basin Study, (Vol. III), 1970.
U.S. Water Resources Council, 1975 National Water Assessment: Flood Damage Cost Methodology, 1976.

[44] U.S. Water Resources Council, The Nation's Water Resources, Second National Assessment, Vol. 2, December 1978, p. 154.



CONTINUED FLOODPLAIN REGULATION: Assumes new construction in most floodplains will be restricted through current floodplain management programs to minimize flood hazards, but improvements to structures and agricultural use of the floodplain will not be restricted.

INCREASED FLOODPLAIN REGULATION: Assumes most non-agricultural floodplains will be regulated, new construction in floodplain will be prohibited, improvements to existing structures will be restricted and some structures will be relocated outside the floodplain.

FIGURE II-21. AVERAGE ANNUAL FLOOD DAMAGES UNDER ALTERNATIVE LEVELS OF FLOODPLAIN REGULATION, UPPER MISSISSIPPI REGION

Sources: UMRCBS Coordinating Committee, *Upper Mississippi River Comprehensive Basin Study*, (Vol. V), 1970
U.S. Water Resources Council, *1975 National Water Assessment: Flood Damage Cost Methodology*, 1976.

percent of the damages.

Many of the flood damage reduction measures appropriate for urban areas are not practical for agricultural areas. Levee projects are often too costly, and floodplain management programs actually encourage agricultural use of the floodplains. For cropland with moderate flood hazards (land inundated once in three years or less) the Federal Crop Insurance Program can alleviate the economic losses resulting from floods. Where flooding occurs more often and causes frequent economic losses, floodplain land may be more useful for recreation areas, timber production, or fish and wildlife habitat. Several federal programs have been established to assist landowners in converting agricultural land to such uses. Another alternative is to plant water tolerant crops in the floodplain which would maintain agricultural use of the land. This alternative is most suited for areas with annual flooding.

Structural alternatives can also be feasible in frequently flooded areas or for highly productive cropland. Small upstream reservoirs constructed through the Watershed Conservation and Flood Prevention Act (P.L. 83-566) provide floodwater storage. Several upstream reservoirs or dry dams can function together to lessen flood stages on small streams and have a cumulative effect on flooding of larger rivers. Reservoirs, however, can reduce wildlife habitat and permanently alter fish habitat. Sedimentation of reservoirs is another problem, which degrades water quality and reduces their effectiveness. Use of dry dams can avoid some of these problems since water is impounded temporarily.

Both urban and agricultural flood damages could be mitigated by efforts to limit rising flood stages. Current relocation and floodplain management programs will be ineffective in preventing damages if the area inundated by floods grows larger and land once considered safe for development is flooded.

Since both the filling of wetlands and the development of floodplain land reduces floodwater storage capability, restricting these activities will curb rising flood stages. Federal compliance with Executive Orders 11990 and 11988 will contribute to floodplain and wetland preservation.

Although draining cropland of excess surface water improves agricultural productivity, it can increase runoff velocity, raise flood peaks, and reduce habitat for upland wildlife and migratory

waterfowl. Encouraging landowners to provide floodwater storage areas when installing drainage systems would mitigate some of these effects.

Urban development and the subsequent increase in impervious surfaces also increases runoff rates. Adoption of local stormwater management plans and subdivision regulations to restrict runoff and require floodwater retention would limit effects on flood stages. Limiting construction of levees would alleviate backwater flooding and rising floodstages.

Conclusion

If none of these alternatives were implemented in urban areas (no action), floods would continue to damage existing structures, development of the floodplain would continue in some areas, disaster assistance outlays would grow, and the stability, health, and safety of communities and their residents would continue to be threatened. In comparison to urban areas, the "no action" alternative in agricultural areas would not threaten health and safety to the same extent nor increase disaster assistance. However, the economic instability and loss of crops caused by floods would continue as an agricultural problem. Additional downstream dams and reservoirs are also not recommended because of the high costs, the large amounts of land taken out of production, and environmental effects.

The restoration of drained wetlands to reduce flood peaks is recommended for further study to determine its effectiveness and economic feasibility. The use of water tolerant crops is recommended for further study to determine various species and their market potential.

Several alternatives are conditionally recommended because their feasibility and acceptability may vary from one community to another. Floodproofing can be an effective and economically feasible alternative. However, floodproofing is not recommended for structures subject to frequent floods because use of the structure is restricted during periods of high water and damages subsequently continue to require disaster assistance and flood insurance expenditures.

Acquisition and relocation of flood-prone structures, or floodplain evacuation, are effective means to prevent flood damage and have the additional benefit of providing floodwater storage and restoring the floodplain's habitat and recreational values. However, floodplain evacuation can be costly or socially unacceptable, especially where floodwaters inundate a major portion of the city.

Implementation of levees and channel modification can be a feasible alternative in urban areas where the benefits exceed the costs, the local interests can afford the local cost share, the damage to environmental resources is minimal or mitigated, and the project is acceptable to local residents. Because of their high costs, limited project life, and the effects of disturbing natural areas these structural alternatives are recommended for areas where nonstructural measures are not feasible and where development has already occurred. Levees are recommended for highly productive agricultural areas provided that the area is not used for urban development once it is protected and flood stages are not increased. Additional upstream impoundments are recommended where valuable habitat areas are not damaged and where locally acceptable.

Where flooding of agricultural land is frequent, an alternative to structural measures would be conversion to open space or recreational areas. For the numerous areas throughout the region where agricultural levees are not cost-effective, financial assistance for landowners to convert to other uses compatible with flooding would alleviate damages.

Improved emergency warning systems, flood fighting plans, and evacuation plans are recommended for all flood-prone areas because the economic and environmental costs are minimal compared to the benefits of reducing property damage and loss of life. Accelerated efforts to preserve floodplains or regulate floodplain development are recommended because they will prevent the spiraling costs of damages and the subsequent expenditures for flood control projects. In addition, environmental values of the floodplain and recreation opportunities are enhanced by floodplain preservation.

Efforts to maintain or increase floodwater storage through wetland pre-

servation and stormwater management are recommended because by reducing runoff rates, additional losses and rising expenditures for flood control will be prevented.

WATER RECREATION

Current Conditions and Problems

Those who have participated in outdoor recreation in the Upper Mississippi Region are not displeased. Their enjoyment of water resource activities generally reflects an atmosphere of spacious conditions and the availability of diverse opportunities. Since the early 1960s, citizens became concerned about the environment and began to look at natural resources as valuable. In this region, protecting a resource is a more pervasive and imperative concern than repairing a damaged one; thus, few serious problems exist, yet some are threatening. Recreational concerns often are caused by more destructive problems such as erosion, sedimentation, water pollution, population intensity, living conditions, and gasoline prices and availability. Since a problem here is rarely in the innate value or quality of a resource or facility, higher population density can initiate a problem or accentuate it.

The most pressing problems expressed by the public relate to the distribution and use efficiency of recreational resources. As a result of the physical geography, most of the resources do not correlate favorably with population density. In the case of rivers and lakes, sufficient access to underutilized rivers and lakes can increase participation and relieve the burden from overutilized areas.[45] Targeting demand from crowded areas in or near urban areas to less popular areas will still preserve the satisfaction at both. Most of water related recreation problems occur near shore areas where land and water activities interact or share space. In Illinois, public water areas close to boat owners' residences cannot comfortably accommodate water-skiing and motorboating. Consequently, much of the boating is on lakes and rivers too small or too shallow for these activities. An additional discomfort to boaters is the lack of sufficient mooring, marina, and storage facilities. The outcome is often a conflict of interests. Other problems grew out of legal constraints or the flexible interpretation of water laws.

Generally, there is ample surface water, parks, and forests in the region to satisfy the recreating public. In Minnesota and Wisconsin, accessible surface water is abundant; in Indiana and Missouri, it is sufficient; but in Illinois, Iowa, and South Dakota it is nominal. The Mississippi River is a source for varied recreation, particularly below Guttenberg, Iowa, where it serves not only as a river but a lake because of the pools and channels. Below Locks and Dam No. 26 the river becomes more open.

State parks are within short distances of most of the population with a large concentration in the Mississippi Headwaters subregion and in the northern portion of the Salt-Sny River Basin.[46] State forests, however, are less accessible including the larger tracts in the Mississippi Headwaters subregion, the St. Croix River Basin, the BlackRoot River Basin (where the Richard J. Dorer Memorial Hardwood Forest dominates land use in the Minnesota portion), and the southern portion of the Kaskaskia-Meramec River Basin.[47] The federal government owns large tracts of forest in the Upper Mississippi Region e.g., the Chippewa National Forest in the Mississippi Headwaters subregion, the Chequamegon National Forest in the Chippewa River Basin, and the Mark Twain National Forest and the Shawnee National Forest in the Kaskaskia-Meramec River Basin (Figure I-7).

Public concern about water pollution as an effect on swimming, fishing, and canoeing is a growing issue. The danger to health is so alarming that water activities are either restricted or discouraged on segments of the Black and

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[45]Underutilized areas never accommodated larger populations especially since access to more popular areas was not restricted. Crowded conditions, however, are often perceived rather than defined by relative values.

[46]No National Parks are in the region.

[47]Forest Richard J. Dorer Memorial Hardwood is in a predominantly agricultural area where the boundary of the Forest is large but the state land ownership is small.

Mississippi rivers in the Black-Root River Basin; on segments of the Pine, Wisconsin, and Yellow rivers and Spring Creek in the Chippewa River Basin; on segments of the Kankakee River in the Upper Illinois River Basin, and on the Sugar Creek and Sangamon and Illinois rivers in the Lower Illinois River Basin. Residents elsewhere, fearing that pollution and over-crowding are the logical outcome of overdevelopment, have voiced concern over industrial and residential construction, conversion of land to agricultural use in shorelands and floodplains, and the transformation of bluff areas. Such noticeable problems are endemic to the St. Croix River valley, and to a larger extent in the Black-Root River Basin, the Maquoketa-Plum River Basin, the Rock River Basin, the Des Moines River Basin, and the Lower Illinois River Basin.

Areas where hunting and fishing are permitted are not adequate throughout the region. In agricultural areas, hunting is restricted to state owned lands or private land where permission has been obtained. State owned lands for hunting are few despite the easements that permit hunting on private lands. Areas for fishing are inadequate in southeastern Minnesota, southwestern Wisconsin, northeastern Iowa, and most of Illinois.

The Chicago metropolitan area and the St. Louis metropolitan area have residential and industrial development that have confined residents to recreational patterns different from other portions of the region. The phenomenon around Chicago pervades that entire subregion in contrast to the St. Louis situation where overcrowded conditions decrease farther from the SMSA. In these two areas the shortage of land recreation opportunities occurs in two forms: major facilities, such as state parks or city beaches that are already overcrowded and in short supply; and local facilities, such as neighborhood parks that are not accessible to all non-driving inner city residents. Around Chicago, the resources of Lake Michigan have not been fully developed for public access and use. Facilities for boating and shore fishing, as well as bathing beaches and park facilities are insufficient to serve the area population.

Where the interests of two activities collide, conflicts invariably occur. On the Mississippi River not only has water pollution restricted some recreational activity but competition with commercial navigation for use of the waterway severely limits the river's use on a few segments. The increase in commercial traffic suppresses recreational use or its potential development. In contrast, recreational use of locking facilities impedes the transport of commodities. In addition, the frequent wakes left by recreational craft and commercial tows disturb small craft nearer shore as well as canoeists and swimmers. Recreational boating accidents on the Mississippi River generally result from inadequate marking of structures and unorganized procedures around locks and dams. Fish and wildlife also suffer from residual effects of other problems.

Certain laws peculiar to individual states have caused problems that have become regional because of interstate recreational travel. Interstate recreational travel is common because the majority of the region's population lives within fifty miles of a state border. In Wisconsin, the proliferation of private properties within large government holdings has caused land use conflicts because of uncontrolled development. In Illinois, streams are being dammed for water supply, navigation, flood control, and power station cooling; they are mined for sand and gravel; and they are channelized for navigation. Such widespread changes have a deleterious effect on recreational opportunities as well as on habitat for wildlife. Yet for continuous canoe passage on many of the streams, channel work and removing debris and sandbars are necessary for a uniform flow.

In Illinois, the public can traverse only "public waters" and only from public access points. Streambeds and lake bottoms belong to the adjacent landowners. As a result, Illinois only can promote recreation on "public waters." Nevertheless, because "public waters" have not been clearly interpreted, the public and landowners are unsure of the correct rights or procedures. In Iowa, on "non-meandered waterways" the streambed and adjacent banks are the property of the landowner through which the stream flows. If the same individual owns property on both sides of the river, the landowner is required by law to construct a fence across to keep livestock within property lines. Fencing streams is an

inconvenience to canoeists.

Anticipated Problems

If activities are already encumbered or disturbed by water pollution, shoreland and floodplain development, or population density, the problem will only increase if no measures are immediately taken to arrest these causes. The problems, however, will not disappear especially since projections indicate an increase in population and more land development. If the problems are threatening, better monitoring of demand, facilities, and conditions could avoid sudden widespread problems (Figure II-22, Table II-25).

Boating hazards will continue to increase unless some changes are made. If some participation demand on lakes is not transferred to other areas and since no new reservoirs are planned, lakes will become more crowded. Efficient use, however, does not include overuse which could occur from overdevelopment of facilities.

Soaring gasoline prices and declining expendable income restrict long distance travel for most people including families and groups who formerly motored in campers. Recreation areas on the periphery of large urban areas are most susceptible to a huge increase in participation. Park visitation will continue to rise and activities such as camping now will be dominated by those who can reach the site within gas-tank range of their home. The more popular areas will continue to be busy, but primarily with those who stay longer in one place. According to the Third Nationwide Outdoor Recreation Plan, the future of parks and other national areas will be characterized by soaring demand during the next five years, an increasingly tight market for open space that remains in the country (especially near cities), rising energy prices, and declining tax revenues.[48]

At the Nationwide Outdoor Recreation Trends Symposium on April 20-23, 1980, several papers reported trends that were especially applicable to surface waters of the Upper Mississippi Region. These trends included: a dramatic increase in trailered boating within and adjacent to large metropolitan areas; a significant increase in canoeing, kayaking, and sailing; a growing popularity in rental boating especially when private enterprise begins to notice the markets; an expected increase in development of marinas and condominium marinas; a growing interest in time-sharing of condominiums, houseboats, and large cruisers and; a potential increase in tent camping because of the possible collapse of the recreational vehicle industry and increasing motel rates.

Portions of the Mississippi Headwaters subregion and the St. Croix River Basin, that already are popular recreation areas, and the relatively unknown areas of the Black-Root River Basin are prone to sudden overcrowding because of their proximity to the Minneapolis-St. Paul metropolitan area.

Increased sensitivity to conservation is essential. Fragile areas, in the same context as deserts and polar regions, comprise sites where the natural setting or artifacts are susceptible to damage that is difficult or impossible to repair. Many of these potential areas in the Upper Mississippi Region are, or are proposed to be, under either federal or state protection and management including the Wild and Scenic Rivers, National Historic Monuments, National Natural Landmarks, and National Historic Properties (Figure II-23).[49] However, two unprotected areas, one at the confluence of the Rock and Mississippi Rivers and the other near St. Louis, contain archeological sites of outstanding importance. Once damaged, these artifacts and the knowledge sought

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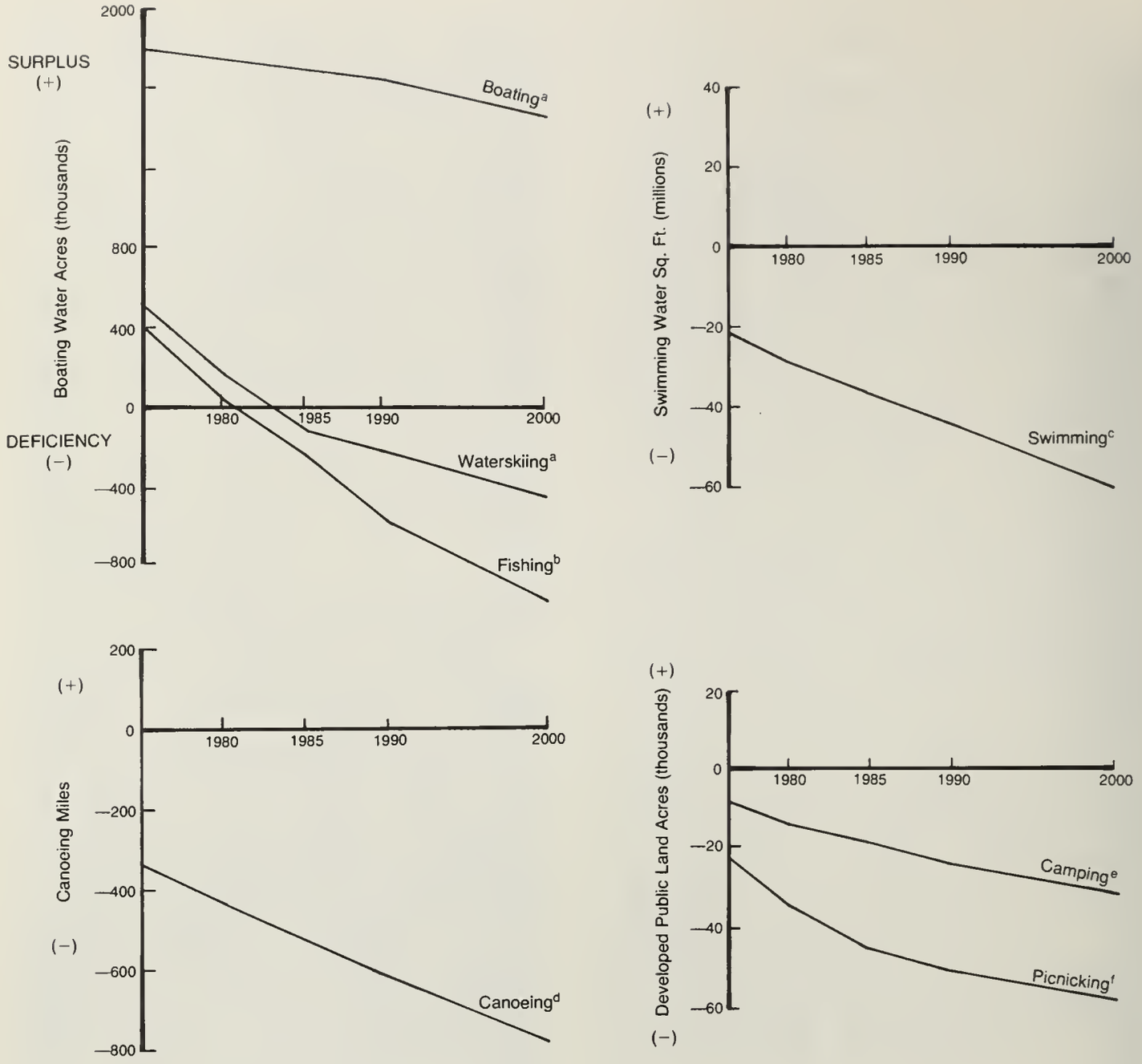
[48]John Yemma, "Cheap-gas Era Is Over; Parks Still Pack in Patrons," Christian Science Monitor, 8 May 1980, p. 5.

[49]By January 1980, those properties which were determined eligible for inclusion in the National Register of Historic Places for the region (aggregated subareas) totaled 121: 25 in the Illinois portion, 25 in the Iowa portion, 11 in the Minnesota portion, 40 in the Missouri portion, and 20 in the Wisconsin portion; U.S. Department of the Interior, Heritage Conservation and Recreation Service, "National Register of Historic Places: Annual Listing of Historic Properties," Federal Register Volume 45 No. 54 part II, (18 March 1980), pp. 17446-17519.



[a] excludes Lake Michigan

[b] excludes streambank fishing

[c] beach and pool swimming; water area assumes developed beach aree

[d] only designated canoe routes

[e] on public and private campgrounds, excludes group campsites

[f] on public picnic grounds

FIGURE II-22. RECREATION FACILITIES* — SURPLUS OR DEFICIENCY, UPPER MISSISSIPPI REGION

*Facilities of the region used only by the population of the region.

Sources: U.S. Department of Agriculture, Soil Conservation Service, *National Erosion Survey*, December 1977.
UMRBC-CCJP, Recreational Forecasts, December 1978 — adjusted May 1980 (for projection methodology consult the Recreation Section of the *Reference Handbook).*

TABLE II-25. WATER RECREATION SUPPLY AND NEED[a], UPPER MISSISSIPPI REGION

	Boating (in 1000 water acres)			Canoeing (in route miles)			Swimming (in 1000 sq. ft.)			Water Skiing (in 1000 water acres)		
	Supply[b]	Need[c] 1980	2000	Supply	Need 1980	2000	Supply	Need 1980	2000	Supply	Need 1930	2000
Upper Mississippi Region	2333	+	+	6575	4277	7804	31367	28797	57204	2275	+	422
Subregions												
Mississippi Headwaters	916	+	+	1356	+	+	13918	+	+	916	+	57
Minnesota	194	+	+	210	+	+	3378	+	+	194	+	+
Saint Croix	75	+	+	322	+	+	263	+	+	75	+	+
Black-Root	122	+	+	359	+	+	643	+	+	122	+	+
Chippewa	107	+	+	545	+	+	314	+	+	107	+	+
Maquoketa-Plum	113	+	+	564	+	+	2181	+	+	113	+	+
Wisconsin	238	+	+	946	+	+	390	+	+	238	+	+
Iowa-Skunk-Wapsipinicon	121	+	28	431	1832	2037	1995	2759	4062	121	85	105
Rock	53	+	+	100	510	713	296	2535	4022	53	+	20
Des Moines	73	+	+	571	621	728	2564	+	+	73	25	34
Salt-Sny	54	+	+	99	53	120	140	622	923	38	+	+
Upper Illinois	55	103	176	426	2469	3871	3779	27490	43971	51	468	697
Lower Illinois	70	+	+	183	359	626	310	5546	8667	70	29	73
Kaskaskia-Meramec	142	+	+	463	1506	2631	1196	7257	11654	105	+	5

	Fishing (in 1000 water acres)			Camping (in camping acres)			Picnicking (in picnicking acres)		
	Supply	Need 1980	2000	Supply	Need 1980	2000	Supply	Need 1980	2000
Upper Mississippi Region	2134	+	925	23147	13804	30129	34091	34671	56094
Subregions									
Mississippi Headwaters	856	+	+	1401	1372	2157	1431	+	61
Minnesota	93	+	+	620	+	+	276	+	+
Saint Croix	90	+	+	713	+	+	686	+	+
Black-Root	53	+	+	1026	+	+	1519	+	+
Chippewa	130	+	+	1627	+	+	1553	+	+
Maquoketa-Plum	98	+	+	1124	+	+	901	+	+
Wisconsin	277	+	+	2669	+	+	2141	+	+
Iowa-Skunk-Wapsipinicon	119	+	36	2080	2196	3879	2316	2403	2934
Rock	67	22	66	2304	+	161	2296	1171	2385
Des Moines	52	+	7	1049	985	1836	1075	779	947
Salt-Sny	53	+	+	918	+	+	1093	+	31
Upper Illinois	33	916	1395	2537	13327	21125	7724	30129	42543
Lower Illinois	77	100	192	2570	420	1906	1275	5956	8322
Kaskaskia-Meramec	135	233	433	2509	2104	4459	9805	+	3752

[a]Need is the difference between projected or actual demand and supply, when the demand is greater.

[b]Supply for each activity is held constant 1975-2000. Supply units for each activity are restrictive; (for complete details of the projection methodology consult the Recreation section in the Reference Handbook).

[c]Numerical Quantities indicate a need; the symbol "+" indicates a surplus of facilities.

Source: UMR8C-CCJP, Recreation Forecasts, December 1978.

after, are lost.

In addition, two larger areas are proposed for public recreation. The proposed Meramec River Recreation Area in Missouri would convert the lower Meramec River into a National Reserve, which would keep lands in local government ownership for use as parklands. In May 1979, a bill was introduced in the U.S. Congress that would establish the Des Moines River Recreational Access and Greenbelt in central Iowa. Essentially a national park, the area would include lands already owned by the federal government within the Saylorville and Red Rock reservoirs, in addition to county and city lands along the river.

Governmental Authority, Responsibility, and Policy

State recreation programs rely to a large extent on two federal acts: the Land and Water Conservation Fund Act of 1965 (P.L. 88-548) and the Historic Preservation Act of 1966 (P.L. 89-665). The Land and Water Conservation Fund is administered formerly by the Heritage Conservation and Recreation Service and currently by the National Park Service of the Department of the Interior, and provides equal matching grants-in-aid programs to the states for the planning, acquisition, and development of public outdoor recreation areas requiring each

POTENTIAL RECREATION SITES (Numbers correspond to FIGURE II-23)

NATIONAL WILD AND SCENIC RIVERS

1. Upper Mississippi R. (MN, 0701)
2. Kettle R. (MN, 0703)
3. Upper Iowa R. (IA, 0706)
4. Wisconsin R. (WI, 0707)

NATIONWIDE RIVERS INVENTORY

1. Prairie R. (MN, 0701)
2. Schoolcraft R. (MN, 0701)
3. Shell R. (MN, 0701)
4. Crow Wing R. (MN, 0701)
5. Moose R. (MN, 0701)
6. Willow R. (MN, 0701)
7. Prairie R. (MN, 0701)
8. Lower Tamarack R. (MN, 0703)
9. Sand Cr. (MN, 0703)
10. Snake R. (MN, 0703)
11. Rum R. (MN, 0701)
12. St. Francis R. (MN, 0701)
13. Blue Earth R. (MN, 0702)
14. Clam R. (WI, 0703)
15. Totagatic R. (WI, 0703)
16. Chippewa R., East Fork (WI, 0705)
17. Flambeau R., South Fork (WI, 0705)
18. Flambeau R. (WI, 0705)
19. Thornapple R. (WI, 0705)
20. Chippewa R. (WI, 0705)
21. Jump R. including North Fork (WI, 0705)
22. Jump R., South Fork (WI, 0705)
23. Somo R. (WI, 0707)
24. Chippewa R. (WI, 0705)
25. Black R., East Fork (WI, 0704)
26. Yellow R. (WI, 0707)
27. Black R. (WI, 0704)
28. Kickapoo R. (WI, 0707)
29. Yellow R. (IA, 0706)
30. Turkey R. (IA, 0706)
31. Volga R. (IA, 0706)
32. Cedar R., upper portion (IA, 0708)
33. West Fork Cedar R. (IA, 0708)
34. Iowa R. (IA, 0708)
35. Wapsipinicon R. (IA, 0708)
36. North Fork Maquoketa R. (IA, 0706)
37. Lytle Cr. (IA, 0706)
38. Maquoketa R. (IA, 0706)
39. Cedar R., lower portion (IA, 0708)
40. English R. (IA, 0708)
41. Middle Raccoon R. (IA, 0710)
42. North Skunk R. (IA, 0708)
43. South Skunk R. (IA, 0708)
44. Skunk R. (IA, 0708)
45. Apple R. (IL, WI, 0706)
46. Plum R. (IL, 0706)
47. Sugar R. (IL, WI, 0709)
48. Big Indian Cr. (IL, 0712)
49. Fox R. (IL, 0712)
50. Big Bureau Cr. (IL, 0713)
51. Vermilion R. (IL, 0713)
52. Spring Cr. (IL, 0712)
53. Sugar Cr. (IL, 0712)
54. Mackinaw R. (IL, 0713)
55. McKee Cr. (IL, 0713)
56. Beaver Cr. (IL, 0714)
57. Shoal Cr. (IL, 0714)
58. Sugar Cr. (IL, 0714)
59. Mud Cr. (IL, 0714)
60. Kaskaskia R. (IL, 0714)
61. Crooked Cr. (IL, 0714)
62. Little Crooked Cr. (IL, 0714)
63. Little Muddy R. (IL, 0714)
64. Beaucoup Cr. (IL, 0714)
65. Galum Cr. (IL, 0714)
66. Big Muddy R. (IL, 0714)
67. Little Fox R. (MO, 0711)
68. Wyaconda Cr. (MO, 0711)
69. Middle North Fork, Fabius R. (MO, 0711)
70. North Fork, South Fabius R. (MO, 0711)
71. South Fabius R. (MO, 0711)
72. Little Fabius R. (MO, 0711)
73. Black Cr. (MO, 0711)
74. North Fork Salt R. (MO, 0711)
75. Crooked Cr. (MO, 0711)
76. Middle Fork Salt R. (MO, 0711)
77. Long Branch (MO, 0711)
78. West Fork Cuivre R. (MO, 0711)
79. North Fork Cuivre R. (MO, 0711)
80. Meramec R. (MO, 0714)
81. Huzzah Cr. (MO, 0714)
82. Courtois R. (MO, 0714)
83. Mineral Fork (MO, 0714)
84. River Aux Vases (MO, 0714)
85. Castor R. (MO, 0714)

NATIONAL TRAILS SYSTEM

1. Northcountry (MN, 0701, 0703)
2. Northwood (MN, 0701)
3. South Washington County Regional Park (MN, 0701)
4. Ritter Farm Park (MN, 0701)

NATIONAL NATURAL LANDMARKS

1. Itasca Virgin Pine (MN, 0701)
2. Clay-Thorpe-Steamboat and Gulch Creek Natural Area (MN, 0701)
3. Sunken Lake Research Area (MN, 0701)
4. Pug Hole Bog (MN, 0701)
5. Crex Meadows (WI, 0703)
6. Plum Lake Hemlock Forest (WI, 0707)
7. Holcombe Conifer Forest (WI, 0707)
8. Schaefer Prairie (MN, 0702)
9. Nerstrand Woods State Park (MN, 0704)
10. Mystery Cave (MN, 0704)
11. Caledonia Oaks Preserve (MN, 0706)
12. Cold Water Cave (IA, 0706)
13. Rush Lake (IA, 0710)
14. Bergo's Slough (IA, 0708)
15. Retz Memorial Woods (IA, 0706)
16. Sand Prairie-Scrub Oak Nature Preserve (IL, 0713)
17. Grand Canyon (IL, 0714)
18. Pomona Natural Bridge (IL, 0714)

STATE PARKS

1. Kinnickinnic River (WI, 0703)
2. Waddam's Creek (IL, 0709)

STATE TRAILS

1. Heartland (MN, 0701)
2. Taconite (MN, 0701)
3. Minnesota-Wisconsin Boundary (MN, 0703)
4. Countryview (MN, 0701, 0703)
5. Minnesota Valley (MN, 0702)
6. Luce Line (MN, 0701)
7. Glacial Lakes (MN, 0701, 0702)
8. Casey Jones (MN, 0710)
9. Douglas (MN, 0704)
10. Stewartville to Leroy (MN, 0704)
11. Root River (MN, 0704)
12. Tuscobia (WI, 0705)
13. Bearskin (WI, 0707)
14. Red Cedar (WI, 0705)
15. Buffalo River (WI, 0704, 0705)
16. LaCrosse River (WI, 0704)
17. Pecatonica (WI, 0706, 0709)
18. Pecatonica Path extension (IL, 0709)
19. Illinois Prairie Path extension (IL, 0712)
20. not named (IL, 0714)

FIGURE II-23. POTENTIAL RECREATION SITES, UPPER MISSISSIPPI REGION

Sources: Iowa Conservation Commission, *1978 SCORP,* 1979.
Minnesota Department of Natural Resources, *Recreational Land Trails*, June 1981. (map)
Minnesota Department of Natural Resources, Bureau of Environmental Planning and Protection, *Minnesota State Comprehensive Outdoor Recreation Plan,* 1980.
U.S. Department of the Interior, Heritage Conservation and Recreation Service *National Recreation Trails,* January 1979.
U.S. Department of the Interior, Heritage Conservation and Recreation Service, "National Registry of Natural Landmarks", *Federal Register,* Vol. 45, No. 232, (December 1, 1980), pp. 79698-79723.
U.S. Department of the Interior, Heritage Conservation and Recreation Service, *National Wild and Scenic Rivers System: As Authorized by P.L. 90-542 as Amended,* January 1979. (map)
U.S. Department of the Interior, Heritage Conservation and Recreation Service, *Nationwide Rivers Inventory – To Identify High Potential Candidates for the National Wild and Scenic Rivers System,* May 1978.
Personal communication with Illinois Department of Conservation, Indiana Department of Natural Resources, Iowa Conservation Commission, Missouri Department of Natural Resources, Wisconsin Department of Natural Resources.

FIGURE II-23. POTENTIAL RECREATION SITES, UPPER MISSISSIPPI REGION

Sources: Iowa Conservation Commission, *1978 SCORP*, 1979.
Minnesota Department of Natural Resources, *Recreational Land Trails*, June 1981. (map)
Minnesota Department of Natural Resources, Bureau of Environmental Planning and Protection, *Minnesota State Comprehensive Outdoor Recreation Plan*, 1980.
U.S. Department of the Interior, Heritage Conservation and Recreation Service *National Recreation Trails*, January 1979.
U.S. Department of the Interior, Heritage Conservation and Recreation Service, "National Registry of Natural Landmarks", *Federal Register*, Vol. 45, No. 232, (December 1, 1980), pp. 79698-79723.
U.S. Department of the Interior, Heritage Conservation and Recreation Service, *National Wild and Scenic Rivers System: As Authorized by P.L. 90-542 as Amended*. January 1979. (map)
U.S. Department of the Interior, Heritage Conservation and Recreation Service, *Nationwide Rivers Inventory – To Identify High Potential Candidates for the National Wild and Scenic Rivers System*, May 1978.
Personal communication with Illinois Department of Conservation, Indiana Department of Natural Resources, Iowa Conservation Commission, Missouri Department of Natural Resources, Wisconsin Department of Natural Resources.

to prepare a state comprehensive outdoor recreation plan (SCORP).[50] SCORPs, however, do not include the Mississippi River.

Funds are also available to federal agencies for acquisition or expansion of nationally significant recreation areas, e.g. National Parks, National Forests, National Recreation Areas, National Wildlife Refuges, and endangered species habitat. The Historic Preservation Fund is also administered by the National Park Service which disburses funds to states for the protection of architectural, archeological, and cultural properties of local, state, regional, and national significance. The amount awarded to each state is based half on the amount requested by the state and half on a competitive score that measures the extent to which the state's proposed work program meets national priorities.[51]

Some of these national priorities are identifying historic properties, strengthening management and accountability of state historic preservation programs, increasing public participation (especially minorities, the disadvantaged, and handicapped), preserving urban neighborhoods, protecting endangered or unique properties, promoting energy conservation, and encouraging non-federal investment and the use of nonprofit revolving funds. Properties are listed or are declared eligible for listing, in the National Register of Historic Places. Historic preservation funds save many properties that would be otherwise destroyed by development, and all subsequent planning incorporates alternatives that avoid adverse effects.

The U.S. Army Corps of Engineers provides funds to state and local areas on a cost-sharing basis through the Federal Water Project Recreation Act of 1965 (P.L. 89-72) in conjunction with projects. Through this program and several others, the Army Corps of Engineers has been increasing emphasis on recreation potential of their projects.

Three federal agencies are significantly involved in water resources recreation: the U.S. Forest Service of the Department of Agriculture, the U.S. Army Corps of Engineers of the Department of the Army, and the National Park Service of the Department of the Interior. Of these, the National Park Service has the largest responsibility (Table II-26).

The National Park Service (NPS) absorbs most of the programs of the former Heritage Conservation and Recreation Service (HCRS).[52] Programs being transferred to the National Park Service include administration of the state portion of the Land and Water Conservation Fund, the Nationwide Outdoor Recreation Plan and State Comprehensive Outdoor Recreation planning, the Urban Park and Recreation Program, Park and Recreation Technical Services, Federal Land Planning, planning for the National Wild and Scenic Rivers System, the National Trails System, Natural Area Programs, the National Register of Historic Places, National Historic Landmarks, Historic Preservation, Technical Preservation Services, National Architectural and Engineering Record, and Interagency Archeological Services.

The National Historic Preservation Act, initially proposed by President Carter in his Environmental Message of 1977, was enacted to establish a National Heritage Program that identifies and protects the nation's most important natural areas and historic places. This program is not a land acquisition program but a resource information program, wherein properties are listed in the Register of Natural Areas (similar to the National

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[50]U.S. Department of the Interior, Heritage Conservation and Recreation Service, "FY 1980 Land and Water Conservation Funds Distributed to States and Federal Agencies," News Release, 12 December 1979.

[51]U.S. Department of the Interior, Heritage Conservation and Recreation Service, "$52 million awarded in Historic Preservation Grants-in-Aid," News Release, 21 December 1979.

[52]On 19 February 1980, Secretary Watt of the U.S. Department of the Interior issued Order No. 3060 which: (1) effected the transfer and consolidation of the major functions of the HCRS into the National Park Service; (2) terminated the residual functions of HCRS; and (3) abolished HCRS as a separate entity of the U.S. Department of the Interior.

TABLE II-26. GOVERNMENTAL AUTHORITY AND RESPONSIBILITY FOR WATER RECREATION - MANAGEMENT, UPPER MISSISSIPPI REGION

Agency	Authority[a]		Primary Program (function)
		U. S. GOVERNMENT	
DEPARTMENT OF AGRICULTURE	S	Wild and Scenic Rivers Act (P.L. 90-542 as amended through P.L. 94-486)	National Wild and Scenic Rivers System (studies components and recommends designation, encourages statewide systems)
U.S. Forest Service	S,R,I	National Forest Management Act of 1976	(protection of water resources in development of forest management plans)
DEPARTMENT OF THE ARMY Corps of Engineers	S,I	Antiquities Act of 1906, Historic Sites Act of 1935	
	I	River and Harbor Act of 1962, Section 103 (P.L. 87-874)	Small Beach Erosion Control
	S,R,I	Federal Water Project Recreation Act of 1965 (P.L. 89-72) and P.L. 86-717 of September 6, 1960	(acquire and manage land for recreation activities in conjunction with projects)
	S,R,I	National Historic Preservation Act of 1966, National Environmental Policy Act of 1969 E.O. 11593 of May 13, 1971	(protection and enhancement of the cultural environment and environmental quality)
DEPARTMENT OF THE INTERIOR	S,I	Federal Lands for Parks and Recreation (P.L. 91-485)	(use of surplus federal real property)
Bureau of Land Management	I	Recreation and Public Purposes Act of 1954 (P.L. 83-387)	(allow state and local authorities to acquire land for recreation)
	S,R	The Federal Land Policy and Management Act of 1976	(manages public domain lands, wilderness review, areas of critical environmental concern)
National Park Service	S	Historic Sites Act of August 21, 1935 and P.L. 74-292	National Register of Natural Areas National Register of Natural Landmarks National Historic Landmarks Program Interagency Archeological Program
	I	Park, Parkway, and Recreation Area Act of June 23, 1936 (P.L. 74-770), National Environmental Policy Act of January 1, 1970 (P.L. 91-190)	National Park System Park and Recreation Technical Assistance (assistance to states and their subdivisions for plans and development)
	S,I	Preservation of Historical and Archeological Data (P.L. 93-291) amendment of P.L. 86-523	(identification, study, and recovery of historic sites)
	I	Land and Water Conservation Fund Act of 1965 (P.L. 88-578)	Land and Water Conservation Fund Grant (grants for states and subdivisions for preparation of recreation plans and for acquisition of recreation areas)
	S,I	Historic Preservation Act of 1966 (P.L. 89-665)	National Register of Historic Places National Trust for Historic Preservation, Historic Preservation Grants-in-Aid
	R,E	Wild and Scenic Rivers Act (P.L. 90-542 as amended through P.L. 94-486)	National Wild and Scenic Rivers System (prepare plans for "under study" rivers, manage and protect designated rivers, encourage statewide systems)
	S,R,I	National Trails System Act (P.L. 90-543 as amended through P.L. 94-527)	National Recreational and Scenic Trails System (study components and recommend designation, encourage state-wide systems)
	S,R,E,I	Executive Order of January 25, 1978	Recreation Resource Program Cultural Heritage Resource Program National Heritage Resource Program
U.S. Fish and Wildlife Service	I	Federal Aid in Wildlife Restoration Act of 1937 as amended	Pittman-Robertson Program (supports projects for restoration and management of wildlife populations, and provides facilities for a hunter safety program)
	I	Federal Aid in Sport Fish Restoration Act of 1950 (P.L. 81-681 as amended)	Dingell-Johnson Program, Federal Aid in Sprot Fish Restoration Program (supports projects to restore and manage sport fish populations)
DEPARTMENT OF TRANSPORTATION Federal Highway Administration, Mississippi River Parkway Planning Commission	I	Federal Highway Act of 1954, Section 14 (P.L. 83-350) and Federal Highway Act of 1976	Great River Road
	S,R	Federal-Aid Highways Act of 1968 (P.L. 90-495) and 1973 (P.L. 93-87)	(preservation of scenic areas while developing highways, feasibility of national system of scenic highways)
U.S. Coast Guard	R,E	Federal Boat Safety Act of 1971 (P.L. 92-75)	(boat safety, develop boating recreation)
	R,E	Ports and Waterway Safety Act of 1972 (P.L. 92-340) and in 1978 (P.L. 95-474)	(boat safety authority during emergencies)
ENVIRONMENTAL PROTECTION AGENCY	S	Clean Water Act of 1977 (section 201)	(evaluation of recreational development in conjunction with wastewater treatment facilities)

TABLE II-26. (Continued)

Agency		Authority[a]	Primary Program (function)
		ILLINDIS	
DEPARTMENT OF CDNSERVATION Bureau of Land and Historic Sites	S	Historic Preservation Act of 1966 (P.L. 84-66S) IL Statutes 127.63A	National Register of Historic Places and Historic Landmarks, Heritage Program, Local and Interagency Assistance
Bureau of Natural Resources	S		Forest Resource Management Program
Bureau of Planning and Development	S,R,E,I	Land and Water Conservation Fund Act of 196S (P.L. 88-S98) IL Statutes 1DS.531, 1DS.S34	State Comprehensive Outdoor Recreation Plan, Recreation Captal Development
		IL Statutes 9S-1/2, 31S	Water Safety Program
		INDIANA	
DEPARTMENT OF NATURAL RESDURCES (and NATURAL RESDURCES DIVISIDN Division of Historic Preservation	S,R,I	Historic Preservation Act of 1966 (P.L. 89-66S)	National Register of Historic Places and Historic Landmarks
Division of Outdoor Recreation		Land and Water Conservation Fund Act of 196S (P.L. 88-S78)	State Comprehensive Outdoor Recreation Plan
Division of Reservoir Management			
Division of State Parks			
		IDWA	
CDNSERVATIDN COMMISSIDN	S,R,I	Land and Water Conservation Fund Act of of 196S (P.L. 88-S78) Code of Iowa, 1D7.3D-1D7.34	State Comprehensive Outdoor Recreation Plan Open Space Land Acqusition Program Projected Water Areas General Plan
STATE ARCHEOLDGIST	S,R	Code of Iowa, 3DS.A	
STATE HISTDRICAL DEPARTMENT Division of Historic Preservation	S,R	Historic Preservation Act of 1966 (P.L. 89-66S)	National Register of Historic Places and Historic Landmarks
		MINNESOTA	
DEPARTMENT OF NATURAL RESDURCES	S,R,I	Land and Water Conservation Fund Act of 196S (P.L. 88-S78)	State Comprehensive Outdoor Recreation Plan
		Minnesota Dutdoor Recreation Act of 197S (MN Statutes 86.71)	(administer outdoor recreation)
		MN Statutes 8S.D71, 86.12	(creation and establishment of state parks, monuments, etc.)
Division of Waters	S,R,I	State Wild and Scenic Rivers Act of 1973 MN Statute 361.26	Wild and Scenic Rivers System, Canoe and Boating Route Planning and Acquisition Program, Public Access Program
		MN Statutes	Lands and Forestry (development of recreation areas in state forests)
		Minnesota Shoreland Management Act of 1969, amended in 1973	Municipal Shoreland Management Program, Shoreland Management Program, Flood Plain Management Program
Land Bureau	S,R	Critical Areas Act of 1973	Critical Areas Program (management)
		MN Statutes 86.41	(acquisition of land for parks and recreation purposes)
MINNESDTA STATE PLANNING AGENCY	S	MN Statutes 86A	(trail planning)
		MISSDURI	
DEPARTMENT OF NATURAL RESOURCES Division of Parks and Historic Preservation	S,R	Federal Project Recreation Act of 196S (P.L. 89-72)	Development Program, Outdoor Recreation Program, National Natural Landmark Program
		Land and Water Conservation Fund Act of 196S (P.L. 88-S78) MD Statutes, Section 2S8.DDD and 1969 revisions	State Comprehensive Outdoor Recreation Plan
		Historic Presentation Act of 1966 (P.L. 89-66S)	National Register of Historic Places Wild Areas Program Missouri National Areas System
Division of Planning and Policy Development	S,I		
		SDUTH DAKDTA	
DEPARTMENT OF GAME, FISH, AND PARKS	S,R,I	Land and Water Conservation Fund Act	State Comprehensive Outdoor Recreation Plan of 1965 (P.L. 88-578)
		South Dakota Session Laws of 1961, Chapter 28D; 1964, Chapter 192; 1966	
PARKS AND RECREATIDN ASSOCIATIDN	S,R,I		

TABLE II-26. (Continued)

Agency	Authority[a]		Primary Program (function)
		WISCONSIN	
DEPARTMENT OF NATURAL RESOURCES (and NATURAL RESOURCES BOARD) Bureau of Parks and Recreation	S,R,I		
Bureau of Water Regulation and Zoning			Hydrology for Proposed Recreation Reservoirs
Division of Environmental Standards			(coordination of water resource management programs)
Office of Planning and Analysis		Land and Water Conservation Fund Act of 1965 (P.L. 88-598)	State Comprehensive Outdoor Recreation Plan, Outdoor Resource Action Plan
DEPARTMENT OF TRANSPORTATION Rustic Roads Board	S	WI Statutes 15.461, 15.465, 83.42	Wisconsin Scenic Roads and Parkways Study (designate roads for hiking, biking, and leisure motoring)
GEOLOGICAL AND NATURAL HISTORY SURVEY	S	WI Statutes, Section 36	(inventory of land and water sources)
WILD RESOURCES ADVISORY COUNCIL	S		Wisconsin Wild Resources System
STATE HISTORICAL SOCIETY	S,R	Historic Preservation Act of 1966 (P.L. 89-665)	Wisconsin Historic Preservation Plan, Natural Area Preservation Program

[a]Scope of authority is defined as follows:
S= Statutory: research, collect information, coordinate, prepare plans
R= Regulatory: establish rules and regulations, issue permits
E= Enforcement: enforce laws and regulations
I= Implementation/Construction: administer funds, acquire land, construct and operate projects

Sources: Executive Office of the President, Office of Management and Budget, 1979 Catalog of Federal Domestic Assistance, May 1979.
U.S. Department of the Army, Chief of Engineers, Digest of Water Resources Policies and Authorities, December 28, 1979.
Clayne R. Jensen, Outdoor Recreation in America: Trends, Problems, and Opportunities, 1977.
Upper Mississippi River Basin Commission, FY 1978 Program Report of State and Federal Water and Related Land Resources Efforts, December 1978.
Upper Mississippi River Basin Commission, Upper Mississippi River Main Stem Level B Study, Technical Paper G: Legal and Institutional, August 1979. (draft)

Register of Historic Places).[53] Federal agencies must consider these properties in their planning and employ alternatives that minimize adverse effects.

The NPS continues its enabling function to administer and operate an extensive system of national parks, monuments, historic sites, and recreation areas. The NPS also assists states, local governments, and citizens groups in the development of park areas, the protection of the environment, and the preservation of historic properties. Wild River Areas, Scenic River Areas, and Recreational River Areas, components of the Wild and Scenic River System; and the National Scenic Trails, the National Historic Trails, and the National Recreation Trails, components of the National Trails System, are designated and managed by the U.S. Department of the Interior following a cooperative study with the U.S. Department of Agriculture. Federal agencies again are charged by Executive Orders to avoid or mitigate adverse effects on designated or potential components of these two systems.

In the second "message on the environment" in August 1979, President Carter underscored the need to strengthen the National Wild and Scenic Rivers

[53]U.S. Department of the Interior, Heritage Conservation and Recreation Service, "National Heritage Program to Identify and Protect the Nation's Most Important Natural Areas and Historic Places Proposed in Congress," News Release, 10 September 1979.

System and to avoid harming rivers which may qualify for inclusion in the system. Each federal agency is instructed to avoid or mitigate adverse effects on rivers identified in the HCRS Inventory and consult with the U.S. Department of the Interior. Otherwise, the Inventory could be depleted before the identified rivers can be fully assessed to determine the desirability of including them as a cooperative venture of federal, state, and local governments. The Ice Age Trail Foundation is an adjunct organization that recruits and maintains participation. During September 1980, the 1000-mile Ice Age Trail became the fifth component of the National Trails System.

In addition to federal responsibilities, three regional agencies participate in the coordination and management of recreation resources near the Minneapolis-St. Paul metropolitan area. This area has a large population and a diverse supply of outdoor recreation resources. The area also contains the St. Croix River, a National Wild and Scenic River and the most popular in the nation. These regional agencies are: the Minnesota-Wisconsin Boundary Area Commission, which is responsible for the administration and management of the St. Croix and the Mississippi river valleys where they form state boundaries; the Lower St. Croix Management Commission, which is composed of representatives of federal and state government agencies to supervise management of the lower portion of the St. Croix River; and the Metropolitan Rivers Corridor Committee, which also is composed of federal and state agency members, and was established recently to enhance recreation in the St. Croix, Minnesota, and Mississippi river corridors.

Water recreation programs at the state level rely on several agencies in each state to protect, enhance, and administer scenic areas, rivers and streams, and to complete the State Comprehensive Outdoor Recreation Plan (SCORP). In Indiana, Minnesota, Missouri, and Wisconsin, the Department of Natural Resources is primarily responsible. In Illinois this responsibility rests with the Department of Conservation, in Iowa with the Conservation Commission, and in South Dakota with the Department of Game, Fish, and Parks.

Alternative Solutions and Effects

Within the Upper Mississippi Region, problems associated with water recreation can be related to four dominant issues.

(1) Inadequate water recreation opportunities. In certain portions of the region crowded conditions indicate the need for additional areas or greater use of underutilized sites.

(2) Inadequate public access to surface water areas. Underutilized recreation areas often result from inadequate access or legal restrictions.

(3) Inadequate facilities. Deteriorating facilities need to be maintained or replaced with better or larger facilities.

(4) Unprotected scenic and natural areas. Fragile areas are scientifically as well as recreationally significant.

(5) Boating hazards and safety. The movement of recreation and commercial vessels conflicts on the traffic lanes and around the locks and dams of the Mississippi River. Traffic movement is impeded and safety is endangered.

Many recreation deficiencies relate to the inventory and distribution of facilities, and their condition, their access, and their recognition. A comprehensive solution to problems which result from these deficiencies, involves the acquisition, protection, and maintenance of recreational areas and marginal lands (Table II-27). Land acquisition can be increased through additional disbursements from the federal Land and Water Conservation Fund. Protection of recreational areas can be improved through increased public awareness and stricter enforcement of laws and safety rules. Those areas such as "natural areas" are irreplaceable because they are unique, and should be acquired to guaran-

TABLE II-27. ALTERNATIVE SOLUTIONS TO WATER RECREATION PROBLEMS AND NEEDS: ANALYSIS EVALUATION[a], UPPER MISSISSIPPI REGION

Alternative Solution (Problem Addressed)	Four Account Effects				Evaluation			Conclusion
	NED	EQ	RED	DSE	Planning Objective	Efficiency	Acceptability	
(1) Improve the monitoring and survey of water recreation activities (Inadequate water recreation opportunities; Inadequate public access to surface water areas)	+ service output	+ surface water quality	- state cost + economic stability	+ recreation + culture	NED,NS	High	High	Recommended
(2) Encourage the use of underutilized recreation areas through information, education, and planning (Inadequate public access to surface water areas: Inadequate water recreation opportunities)	+ service output	+ natural areas + fish & wildlife habitat	+ economic stability	+ health & safety + recreation	EQ,NS	High	High	Recommended
(3) Acquire and develop new recreation areas (Inadequate water recreation opportunities; Unprotected scenic areas)	+ service output - commercial output - national cost	- natural areas - surface water quality	+ jobs + economic stability - local cost - state cost	+ real income + recreation - culture	NED,RED	Medium	Medium	Conditionally Recommended
(4) Increase the maintenance or improvement of existing recreational facilities and access (Inadequate facilities)	+ service output - commercial output	+ natural areas + surface water quality	- state cost - local cost + jobs	+ recreation + health & safety	EQ,RED	High	High	Recommended
(5) Eliminate regulations that impede access to recreation sites or impede movement on recreational waters (Inadequate public access to surface water areas; Inadequate	+ service output - state cost	- surface water quality - erosion control	- local cost - state cost - economic stability	- real income + recreation	RED,NS	High	Low	Conditionally Recommended
(6) Preserve and protect the rivers and streams with the highest recreational values and incorporate water surface management policies as part of all comprehensive planning processes (Unprotected scenic and natural areas)	+ service output - commercial output	+ fish & wildlife habitat + surface water quality + erosion control + natural areas	- state cost - economic stability	+ aesthetics	EQ,RED	High	Medium	Recommended
(7) Preserve and protect natural areas that are important for recreational and scientific values (Unprotected scenic and natural areas)	+ service output - commercial output	+ fish & wildlife habitat + natural areas + surface water quality	- state cost - economic stability	+ culture + recreation + aesthetics	EQ,NS	High	Medium	Recommended
(8) Increase the enforcement and public education of boating regulations to prevent boating accidents (Boating hazards and safety)	+ navigation	xx	- state cost	+ recreation + health & safety	DSE	High	Medium	Recommended
(9) Develop "lockage waiting areas" at each lock and dam (Boating hazards and safety)	+ navigation	xx	- state cost	+ health & safety	DSE	High	High	Study
(10) No action	- service output - national cost	- fish & wildlife habitat - erosion control - natural areas	- economic stability + state cost + local cost	- recreation - real income - aesthetics - health & safety		Low	Low	Not Recommended

[a]Abbreviations in the Table: NED (National Economic Development), EQ (Environmental Quality), RED (Regional Economic Development), DSE (Other Social Effects), NS (Nonstructural), XX (Not applicable)

For complete definition of Effects, Planning Objectives, Efficiency, Acceptability, and Conclusions see Appendix E.

tee their protection.[54]

Archeological resources can be managed and preserved through continuous education and legislation (the Historic Sites Preservation Act, the National Environmental Policy Act, and the Archeological and Historic Preservation Act) and with emphasis in regional planning.

Numerous streams in the region still retain sufficient aesthetic and recreational values to warrant their long-term protection. Several streams are candidates for inclusion in a state wild and scenic rivers system, or for stricter protection and control in the National Wild and Scenic Rivers System. Protection by states often involves programs that enhance the aesthetic quality of streams and provide recreation. Such programs should incorporate water surface zoning (speed and noise) and water surface management policies as part of all comprehensive planning processes. Access sites are being acquired through the assistance of local governments and the cooperation of riparian owners for passage easements. As an attempt to avoid the loss of more recreation stream mileage, each state could inventory its recreation and fishing streams and accord a protection program similar to the state

[54]Natural areas and nature preserves are areas where the physical conditions are unique and original yet representative of a region.

wild and scenic rivers system in Minnesota.

The direct provision of outdoor recreation areas in the region by the federal government is limited. The establishment of a federal reserve of land and water is usually based upon a natural or cultural resource value having national or multi-state significance. The quantity and quality of urban recreation in the Chicago metropolitan area and the St. Louis metropolitan area can be increased by several sectors--federal, state, local, and private--and local participation is vital to the solution of recreational needs.[55] Allocation of Land and Water Conservation funds to local governments would directly alleviate some urban recreation deficiencies.

The nature of recreational opportunities may explain some of the differences in participation but increased site recognition can redistribute participation as well as adjust attendance Utilization of recreational facilities would be most efficient when their distribution coincides with that of the population and its recreational interests. The former Heritage Conservation and Recreation Service (now consolidated in the National Park Service) tabulated recreational demand and supply data for regions. These surveys relied on a small sample and consequently were too superficial for planning use. States have been using their own more detailed surveys for several years now with varied success, but combining their methods has been the only attempt at a regional survey and projections system. If a regional recreational survey was regularly used and in conjunction with long-term land use planning, the severity of many recreation deficiencies could be better assessed.

Increased recreational use has a number of ramifications. Land use in some cases would change primarily from vacant or idle land to recreational land. In other areas, land uses would be intensified e.g., existing forest preserves would attract and could accommodate more recreation. Land values may be enhanced, especially in residential areas from their proximity to improved recreational activities. On the other hand, there are potential negative ramifications. Increased use of the waterways could create localized water quality problems from intensive use in addition to disturbing fish and wildlife. Specific recreational sites, especially in high density areas could easily become overused, resulting in a general degradation of that particular recreational resource. Broad networks of less concentrated facilities could alleviate these problems.[56] In sum, careful planning of the amount and location of access to public recreational facilities would optimize the utilization of the resource.

Many river recreation problems, especially on the Mississippi, result from congestion at locks and harbors and use conflicts between recreational and commercial interests. Construction of additional mooring and ducking facilities and adherence to boating laws will distribute traffic and reduce conflicts. On lakes where boat mooring facilities are generally exhausted, restrictions should be implemented. Boating accidents could be prevented if the public were better informed about safety and the laws were adequately enforced.[57] Recommendations by GREATs I and II address these issues.

Recreation problems can be solved or alleviated if programs and projects addressed land acquisition, resource protection, use efficiency, and citizen awareness and participation. Without the implementation of any alternative in recreation planning (no action), the optimal and efficient use of land and water resources in the future can not be guaranteed. Damage to unique areas will become irreversible, and crowded areas will become unattractive.

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[55]U.S. Department of the Army, Corps of Engineers, Urban Water Damage Study: The Chicago Underflow Plan, Environmental Impact Statement, December 1975.

[56]Using cooling pond facilities to help fulfill some of the water oriented recreation needs, requires further research before appraisal as an alternative or adopted as a recommendation.

[57]Great River Environmental Action Team, A Study of the Upper Mississippi River: GREAT I Main Report, September 1980 and Great River Environmental Action Team, GREAT II Main Report, December 1980.

Conclusion

Without the implementation of any alternative in water recreation planning (no action), recreational resource management will not respond to changing social and economic conditions.

Solutions are intended to maximize safe and efficient use of resources through continous monitoring of needs, increasing use of underutilized areas, mitigating boating hazards, and through removing restraints to access. In areas where laws have restricted access to surface water areas, public approval would expedite changes. Efficient use of natural resources also involves anticipation of trends by providing recreation for the future. New recreation areas will be developed only in areas where participation can not be redistributed. Scenic and natural areas are irreplaceable and need to be protected.

Current Conditions and Problems

Loss of habitat is the major problem facing fish and wildlife in the Upper Mississippi Region. Habitat has been lost because of wetland drainage, poor agricultural practices, stream alteration, and residential and industrial development. Many species are in danger of extinction because they have specific habitat requirements and these habitats have been eliminated or degraded (Table II-28). Besides those species designated threatened or endangered at the federal level, many more species have been designated by state agencies as threatened, endangered, or of undetermined status. The osprey, piping plover, upland sandpiper, Blanding's turtle, lake sturgeon, and gravel chub are species that are dependent on water resource habitats and have commonly been listed by states as threatened or endangered. Wetlands, streams, lakes, reservoirs, and associated riparian areas are all valuable as fish and wildlife habitat. The U.S. Fish and Wildlife Service (USFWS) and the states all have mechanisms for identifying and preserving unique natural areas, however, there is a need for a consolidated source of information regarding such areas that might be threatened in the future.

Wetlands provide nesting and feeding areas for numerous species of migratory waterfowl and furbearers. Upland game species such as deer and pheasants utilize wetlands for cover, especially in agricultural areas. Wetlands adjacent to streams and lakes provide spawning areas for several species of fish, particularly northern pike. Wetlands also provide several beneficial hydrologic functions, including runoff storage. Runoff stored in wetlands is released slowly, mitigating flooding and sustaining streamflows. The dense vegetation often found in wetlands acts as a filter to trap sediments and pollutants, maintaining the quality of nearby waters. In some areas, wetlands are also sites of groundwater recharge.[58]

Despite these useful functions, wetlands are being drained for agricultural and development. Current data for wetland drainage for the region do not exist because the most recent national wetland survey was completed in 1954. The current rate of drainage nationwide is estimated at 300,000 acres per year, and a large portion of this drainage takes place in the region. Wetland acreage in Iowa for example, has declined from 6,000,000 in 1900 to 55,000 in 1977, a decrease of 99.1 percent.[59] occurred in Illinois, Minnesota, Missouri, and Wisconsin. The formation of levee districts along the Illinois River and lower Mississippi River resulted in the extensive drainage of floodplain wetlands.

Several problems exist for wetland protection programs. Increasing demand for agricultural products makes wetland drainage and conversion to cropland more feasible economically. Also, government acquisition programs are hindered by increasing land or mined prices coupled with relatively constant funding levels, and by increasing public sentiment against government control of wetlands.

In addition to the drainage of wetlands, streambanks and riparian forests are cleared to facilitate expanding agriculture. Timber clearing leads to higher erosion rates and loss of valuable riparian habitat. Conversion of riparian forest for cropland or pasture has been extensive in Iowa and Illinois.

Sediment from agricultural land runoff and eroding streambanks is the major cause of fish habitat degradation. Sediments fill pools, cover spawning substrates, smother aquatic invertebrates, increase turbidity, and facilitate the transport of nutrients and toxic substances into streams and lakes. Sedimenta-

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[58]Comprehensive discussions of wetland types, values, and preservation measures are presented in several documents including: U.S. Department of the Interior, Fish and Wildlife Service, Wetlands of the United States, Circular 39, 1971, and; Council on Environmental Quality (coor.), Interagency Task Force Report, Our Nations Wetlands, by Elinor Horwitz, 1978.

[59]U.S. Environmental Protection Agency, Profile of Environmental Quality: Iowa, September 1980.

TABLE II-28. FEDERAL ENDANGERED AND THREATENED SPECIES, UPPER MISSISSIPPI REGION

Common Name (Scientific Name)	Status[a]	Distribution (states)
VERTEBRATES		
Gray Wolf (Canis lupus)	E,T[b]	MN,WI
Indiana Bat (Myotis sodalis)	E	IL,IN,IA, MO, WI
Gray Bat (Myotis grisescens)	E	IL,MO
Bald Eagle (Haliaeetus leucocephalus)	E,T[c]	IL,IN,IA,MN,SD,WI[d]
Peregrine Falcon (Falco peregrinus)	E	IL,IN,IA,MN,MO,SD,WI[e]
Kirtland's Warbler (Dendroica kirtlandii)	E	IL,IN,WI[f]
INVERTEBRATES		
Higgin's Eye Pearly Mussel (Lampsilis higginsi)	E	IL,IA,MN,MO,WI
Pink Mucket Pearly Mussel (Lamsilis orbiculata)	E	IA,MO
Fat Pocketbook Pearly Mussel (Potamilus capax)	E	IA,MO
Curtis' Pearly Mussel (Epioblasma florentina curtisi)	E	MO
Iowa Pleistocene Snail (Discus macclintocki)	E	IA
PLANTS		
Northern Wild Monkshood (Aconitum noveboracense)	T	IA, WI

[a]E(Endangered): in danger of extinction throughout all or a significant portion of its range

[b]T(Threatened): likely to become endangered within the foreseeable future

[c]Threatened in Minnesota and Wisconsin, endangered in other states

[d]Bald eagles migrate or winter throughout the region, but breeding sites are known only in Illinois, Iowa, Minnesota, and Wisconsin.

[e]Peregrine falcons exist throughout the region as migrants only. No breeding is known to occur.

[f]Kirtland's warblers exist in IL and IN as migrants only. Breeding is known to occur only in Michigan and Wisconsin.

Sources: U.S. Department of the Interior, Fish and Wildlife Service, Endangered Species, Great Lakes Region September 1980. Updated April 1981.
Personal communication with the U. S. Fish and Wildlife Service, March 1981.

tion of streams has drastically altered habitat in Illinois, Iowa, northeast Missouri, and southeast Wisconsin. In Illinois, sedimentation is responsible for reducing populations of sixteen fish species.[60] Sedimentation is a major problem in the backwaters and wetlands adjacent to the Illinois and Mississippi rivers.

Stream channelization for drainage and flood control has also drastically altered fish habitat. Channelization results in uniform depth and width and reduced stream length. Channelization has been most extensive in Illinois, Iowa, and northeast Missouri.

Numerous fish and wildlife problems are associated with navigation activities along the Mississippi and Illinois rivers. Navigation activities that adversely affect fish and wildlife include barge traffic, dredging and spoil disposal, construction of wing and closing dams, manipulation of pool levels, and barge fleeting. There is a lack of information concerning the extent to which these activities affect side channels and backwaters and the feasibility of dredging sedimented areas and controlling pool water levels to mitigate habitat losses. The U.S. Army Corps of Engineers lacks adequate funding and definitive authority to carry out such mitigation measures.

Barge traffic temporarily increases turbidity by resuspending sediments, and in some areas waves generated by barge

[60]Illinois Natural History Survey, Illinois Streams: A Classification Based on Their Fishes and an Analysis of Factors Responsible for Disappearance of Native Species, Biological Note No. 76, by P.W. Smith, November 1971.

traffic increase bank erosion. To maintain the 9-foot navigation channel, dredging is necessary which temporarily increases turbidity and may resuspend toxic substances. The disposal of dredged material is the most serious form of habitat destruction on the Mississippi River. Dredged material placement in backwaters has eliminated fish and waterfowl habitat and has caused some sloughs to become stagnant. Deposition of material in or along the main channel covers mussel beds and fish habitat. The construction of wing dams results in the deposition of sediments and a decrease in the surface area of the stream. The construction of closing dams reduces flow through backwaters, resulting in increased sedimentation and oxygen depletion. Wing dams and closing dams have significantly altered habitat on the Mississippi River below St. Louis, eliminating many backwaters and reducing the total water area. The manipulation of pool levels for navigation affects the production and survival of fish, waterfowl, furbearers, benthos, and aquatic plants.[61] Finally, navigation activities in barge fleeting areas resuspend sediments, resulting in increased turbidity and lowered plant production. These sediments settle downstream and can bury mussel beds. Concern for mussels centers on fingernail clams, an important food for waterfowl during migration, and several endangered species.

The use of lead shot for waterfowl hunting has become a controversial issue. Waterfowl ingest lead shot during feeding and at certain times of the year are highly susceptible to lead poisoning. An estimated 1.6 to 2.4 million waterfowl die annually from lead shot poisoning in North America.[62] Approximately 3100 dead geese were recovered in the spring of 1981 in central Wisconsin, but the total number of deaths was estimated at 5000. At least 95 percent of the deaths were attributed to lead shot poisoning.[63] Many waterfowl hunters are concerned that the use of non-toxic steel shot will result in increased number of crippled ducks. Recent studies in California, Missouri, and other states using volunteer hunters and unmarked shells show no statistically significant difference in the crippling rates of lead and steel shot.

Funding for most fish and wildlife habitat acquisition and development programs is provided by conservationists and sportsmen. Most of this money is intended to benefit game species, but much of the improved or protected habitat is also beneficial to nongame species. Nongame species (some of which are threatened or endangered) have recently received more emphasis because of increased public awareness and interest in ecology. Increased funding for nongame programs is needed to monitor and restore species which have been extirpated from certain areas or are in danger of extinction.

Sport fisheries programs also need increased funding. The number of anglers is increasing, exerting a high demand on fishery resources, especially those near population centers. Exotic species have been introduced in the past to meet these demands but with varying success.[64] Probably the most harmful introduction was the German carp which dominate the fish population in many warmwater lakes and streams and through their herbivorous feeding habits accelerate lake eutrophication and destroy fish and waterfowl habitat.

Pesticides and heavy metals also cause problems for fish and wildlife in many areas of the region. Pesticides are the major cause for the decline of bald eagle and peregrine falcon populations, and have caused fish and aquatic insect kills in many areas of the region. Some pesticides and heavy metals bioaccumulate

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[61]Illinois Natural History Survey, "Information Summary of the Physical, Chemical, and Biological Effects of Navigation", by K.S. Lubinski, H.H. Seagle Jr., et. al., September 1980. (draft)

[62]Personal communication with the U.S. Department of Interior, Fish and Wildlife Service, April 1981.

[63]Personal communication with the Wisconsin Department of Natural Resources, April 1981.

[64]Examples of successful introductions include brown and rainbow trout. To meet hunting demands, pheasant and Hungarian partridge were successfully introduced. The starling and house sparrow were introduced from Europe and have been harmful to native bird populations.

in fish and wildlife, and this has occurred to such an extent in the Mississippi River that limits have been placed on fish consumption.

Anticipated Problems

Loss of habitat will remain the major problem for fish and wildlife. Wetland drainage is expected to continue because of increased demands for agricultural products, while rising land prices and increasing sentiment against government acquisition of wetlands will hinder wetland preservation efforts. Sedimentation and pollution of streams and lakes will continue to destroy aquatic habitat unless erosion from agricultural land is reduced or controlled. Conflicts between navigation and fish and wildlife interests along the Mississippi, Illinois, and Kaskaskia rivers are expected to increase. Acid rain threatens aquatic habitat in northern Wisconsin and northern Minnesota. Finally, increasing numbers of hunters, anglers, and nature study enthusiasts are expected to increase demand for fish and wildlife related recreation opportunities, especially near densely populated areas.

Governmental Authority, Responsibility, and Policy

State and federal agencies share management of fish and wildlife resources through numerous programs and projects (Table II-29). The U.S. Fish and Wildlife Service (USFWS) of the Department of the Interior has broad responsibilities shared with state and federal agencies to protect public interest in the areas of conservation and management of fish and wildlife and their habitats; maintenance and improvement of water quality, aesthetics and general recreational use as related to fish and wildlife resources; and the preservation, maintenance, restoration, and enhancement of aquatic ecosystems. The USFWS also cooperates with state and other state and federal agencies in analyzing fish and wildlife needs and recommending programs for protection and enhancement of fish and wildlife habitat.

Several congressional acts have authorized funds to be administered by the USFWS for the establishment of wildlife areas, and for research and management programs. The Migratory Bird Hunting Stamp Act provides funding for acquisition of National Wildlife Refuges and Waterfowl Production Areas. The Federal Aid in Wildlife Restoration (or Pittman-Robertson) Act and the Federal Aid in Sport Fish Restoration (or Dingell-Johnson) Act provide funds to states for fish and wildlife habitat acquisition, research, and management. The sources of Pittman-Robertson and Dingell-Johnson funds are excise taxes on hunting and fishing equipment.

The Fish and Wildlife Coordination Act (FWCA) is the basis for many of the authorities and responsibilities of the USFWS. The Act requires federal agencies that undertake water development projects to consult with state and federal wildlife agencies in order to provide wildlife conservation equal consideration with other features of the projects. The FWCA also requires preparation, submission to Congress, and implementation of a plan to mitigate and compensate wildlife losses due to the projects.[65]

The FWCA was in many respects the forerunner of the National Environmental Policy Act (NEPA), which was originally introduced as an amendment to the Fish and Wildlife Act. The NEPA created the Council on Environmental Quality as the major advisor to the President on environmental matters, and required the preparation of environmental assessments and impact statements.

The Endangered Species Act is the major federal law passed to specifically conserve species in danger of extinction. The Act authorizes the Secretary of the Interior to identify endangered and threatened species, designate habitats critical to their survival, establish programs for their recovery, and cooperate with states to assure their survival. It also prevents federal agencies from authorizing, funding, or implementing any action which may jeopardize the existence of or modify the habitats

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[65]U.S. Department of the Interior, U.S. Department of Commerce, "Fish and Wildlife Coordination Act; Notice of Proposed Rulemaking," Federal Register, Volume 44, Number 98, (18 May 1979), pp. 29300-29359.

TABLE II-29. GOVERNMENTAL AUTHORITY AND RESPONSIBILITY FOR FISH AND WILDLIFE MANAGEMENT AND PROTECTION, UPPER MISSISSIPPI REGION

Agency	Authority[a]		Primary Program (function)
		U.S. GOVERNMENT	
COUNCIL ON ENVIRONMENTAL QUALITY	S,R,I	National Environmental Policy Act of 1969 (P.L. 91-190)	(systematic approach in planning to reduce harmful environmental effects)
	S,R,E	Executive Order 11990 of May 24, 1977	(requires federal projects to protect wetlands)
	S	Executive Order 11988 of May 24, 1977	(floodplain preservation, protection and enhancement of environmental quality, guidelines for implementing procedural provision of NEPA)
DEPARTMENT OF AGRICULTURE	S,R,I	National Environmental Policy Act of 1969 Executive Order 11990	(wetlands preservation and protection)
Agricultural Stabilization and Conservation Service	S,R	Water Bank Act (P.L. 91-599)	(preserve, restore, and improve wetlands)
DEPARTMENT OF THE ARMY Corps of Engineers	S,R,I	National Environmental Policy Act of 1969 Executive Order 11990	(wetlands preservation and protection)
	S,R	Clean Water Act of 1977 (section 404)	(controls discharges into navigable waters)
	S,I	Water Resources Development Act of 1974 (P.L. 93-251) amends P.L. 89-72	(fish and wildlife enhancement)
	S,I	Water Resources Development Act of 1976, Section 150	(establish wetlands as part of water resources development projects)
DEPARTMENT OF THE INTERIOR	S,R,I	National Environmental Policy Act of 1969, Executive Order 11990	National Wetlands Acquisition Program (wetlands preservation and protection)
Endangered Species Interagency Committee	I	Rare and Endangered Species Act of 1973 (P.L. 93-205) and P.L. 95-632 Amendments	Endangered Species Conservation Program, Critical Habitat Determination, Unique Wildlife Ecosystem Program
National Park Service	I	Land and Water Conservation Fund Act of of 1965 (P.L. 88-578)	Land and Water Conservation (LAWCON) Fund (grants for states and subdivisions for preparation of recreation plans and for acquisition of recreation areas)
U.S. Fish and Wildlife Service	S,R	Upper Mississippi River Refuge Act of 1924, and subsequent Acts for wildlife refuges	(wildlife refuges)
	S,R, E,I	Migratory Bird Conservation Act of 1929	(lands for migratory bird refuges)
	S,R	Fish and Wildlife Coordination Act of 1934 as amended by Act of 1958 (P.L. 85-624), Fish and Wildlife Act of 1956	Wildlife Technical Assistance, Wildlife Ecology Research Information, Cooperative Wildlife and Fishing Units Program, Ecolgical Services, Fishery Resources Management Program, National Wildlife Refuge System
	S,R	Migratory Bird Hunting and Conservation Stamp Act of 1934	(supports Migratory Bird Conservation Fund)
	S,I	Soil Conservation Act of 1935, Fish and Wildlife Coordination Act of 1958 (P.L. 85-624)	Farm Pond Stocking
	I	Federal Aid in Wildlife Restoration Act of 1937	Pittman-Robertson Program (supports administration of hunter safety programs and research, habitat acquisition, and management of wildlife populations)
	I	Federal Aid in Sport Fish Restoration Act of 1950 (P.L. 81-681) as amended	Dingell-Johnson Program (support projects to restore and manage sport fish populations)
	S	Fish and Wildlife Act of 1956 as amended, Fish and Wildlife Coordination Act of 1958, Fishery Experiment Station Act of 1958	(develop and disseminate information for protection and enhancement of fishery resources)
	R,E	National Wildlife Refuge System Act (89-669)	National Wildlife Refuge System, Bicentennial Land Heritage, Law Enforcement Program (management of refuges)
	I	Wetlands Loan Act of 1961 (P.L. 87-383 amended through P.L. 90-205 and 94-215)	(acquisition of waterfowl habitat)
	S,R,I	Fish and Wildlife Act of 1974 (P.L. 93-271) as amended	(develop, protect, conserve, manage fish and wildlife resources)
	S,R	Clean Water Act of 1977 (section 404)	(controls discharges into navigable waters)
	S,I	National Heritage Policy Act of 1979	National Register of Natural Areas, National Heritage
	S,I	Fish and Wildlife Conservation Act of 1980 (P.L. 96-366)	(authorizes funding to states for nongame conservation, requires USFWS to study alternative nongame funding sources)
ENVIRONMENTAL PROTECTION AGENCY	S,R,I	National Environmental Policy Act of 1969	(review of Environmental Impact Statements)
	S,R	Clean Water Act of 1977 (section 404)	(control of dredged or fill material into navigable waters)

TABLE II-29. (Continued)

Agency		Authority[a]	Primary Program (function)
		ILLINDIS	
DEPARTMENT OF CONSERVATION	S,R	Game Code of 1971, Illinois Endangereo Species Act	Acres for Wildlife, Roadsides for Wildlife, Technical Land Assistance Program, Illinois Migratory Waterfowl Stamp
Bureau of Administration Services			(fish and game licenses, LAWCON grants)
Bureau of Natural Resources		IL Statutes, Chapters 56, 61, 63a, 12f	(fish, wildlife, and forest resource management)
Bureau of Planning and Development			(planning, coordination of construction proposals)
INSTITUTE OF NATURAL RESOURCES	S,R,I	IL Statutes, Chapter 127, Section 62	Natural History Survey
Wildlife Resources Division			
NATURE PRESERVES COMMISSION	R,I		(inventory of natural areas)
		INDIANA	
DEPARTMENT OF NATURAL RESOURCES		IN Statutes	
Division of Fish and Wildlife	S,R,I		(fish and wildlife research and management, administration of state fish and wildlife areas) Indiana Migratory Waterfowl Stamp
Division of Forestry	S,R,E		(forest resource management)
Division of Nature Preserves	S,R,E,I		Nature Preserves
Division of Reservoirs Management	S		
		IDWA	
CONSERVATION COMMISSION	S,R,E,I	IA Code, Chapters 106-112	(administers Sate Fish and Game Protection Funds, administers wildlife areas and natural areas, conducts fish and wildlife research and management, administers non-sport fisheries inventory and non-consumptive wildlife users survey)
		Duck Stamp Bill of 1972	Iowa Migratory Waterfowl Stamp
			Iowa Habitat Stamp
		Protected Water Area Bill	(protects unique water areas)
STATE PRESERVES SYSTEM	R,I	IA Code, Chapter 111B	(identifies preserves)
		MINNESOTA	
DEPARTMENT OF NATURAL RESOURCES Bureau of Land	S,I	MN Statutes 84.033, 97.481	Scientific and Natural Areas Program, Acquisition of Wildlife Lands
		MN Statutes of 1978	Water Bank Program (wetland acquisition, conservation, protection)
		MN Statutes 84.D24, 85.D15	(access to wilderness areas, forest wildlife management areas, water sites)
Division of Fish and Wildlife	S,R,E	MN Statutes 86A, 97.481	(fish and wildlife management and research) Ecological Services Program, Minnesota Migratory Waterfowl Stamp, State Wetland Inventory, Non-game Wildlife Program
Division of Waters	S,R		State Wetland Inventory, Lake and Stream Inventory, Protected Waters Permits
Office of Planning	S		Minnesota Heritage Program (identified natural communities, plant and animal species, and geologic formations in need of protection)
DEPARTMENT OF REVENUE	S	MN Statutes, Sections 272.021 & 273.115	Wetland Protperty Tax Credit Program (provides tax credits to landowners with wetlands)
		MISSOURI	
DEPARTMENT OF CONSERVATION Field Activities Division	S,R,E	MO Statutes	Natural Areas Survey
Fisheries Division	S,R		(fisheries research, management, hatcheries)
Forestry Division	S,R,E		Manages and protects forests
Wildlife Division	S,R,I		(wildlife research and management)
			Missouri Waterfowl Hunting Stamp
DEPARTMENT OF NATURAL RESOURCES	S,R,E,I		Natural History Program, Natural Areas Survey
		SOUTH DAKOTA	
DEPARTMENT OF GAME, FISH AND PARKS	S,R	SD Session Laws Acres for Wildlife	(fish and wildlife management)
PARKS AND RECREATION ASSOCIATION	S		(planning for fish and wildlife resources)

TABLE II-29. (Continued)

Agency	Authority[a]		Primary Program (function)
WISCONSIN			
DEPARTMENT OF NATURAL RESOURCES			
Division of Resource Management			
Bureau of Fish Management	S,R	WI Statutes 144	(fisheries management, research, and planning) Lake and Steam Inventory and Classification, Trout Stream Inventory and Classification
Bureau of Planning	S,I	WI Statutes 23.32	Wetlands Inventory (wetlands mapping)
Bureau of Wildlife Management	S,R	WI Statutes	(wildlife management, research, and planning) Wisconsin Migratory Waterfowl Stamp Program
Office of Endangered and Nongame Species	S,R,E	WI Statutes	
Office of Lands	S	WI Statutes	

[a]Scope of authority is defined as follows:
S= Statutory: research, collect information, coordinate, prepare plans
R= Regulatory: establish rules and regulations, issue permits
E= Enforcement: enforce laws and regulations
I= Implementation/Construction: administer funds, acquire land, construct and operate projects

Sources: Executive Office of the President, Office of Management and Budget, 1979 Catalog of Federal Domestic Assistance, May 1979.
U.S. Department of the Army, Chief of Engineers, Digest of Water Resources Policies and Authorities, September 28, 1979.
U.S. Department of the Interior, U.S. Fish and Wildlife Service, Selected List of Federal Laws and Treaties Relating to Fish and Wildlife, rev. December 1976.
Upper Mississippi River Basin Commission, FY 1978 Program Report of State and Federal Water and Related Land Resources Efforts, December 1978.
Upper Mississippi River Basin Commission, Upper Mississippi River Main Stem Level B Study, Technical Paper G: Legal and Institutional, August 1979. (draft)

of threatened or endangered species.[66]

Wetland preservation is a national priority and has evolved into a federal and state responsibility which encourages the private sector to implement wetland preservation and restoration. The majority of small wetlands are in private ownership. Many of the larger tracts are owned and managed by the states or the USFWS. The Water Bank Program, administered by the U.S. Department of Agriculture (USDA), Agricultural Stabilization and Conservation Service, preserves wetlands by paying farmers not to drain. The program applies primarily in Minnesota and South Dakota. The USDA pays the landowner an annual sum on a ten-year agreement, and in 1980 provisions were made to adjust payment rates according to local agricultural economic factors. Although the primary objective of the Water Bank Program is waterfowl habitat preservation, other objectives include flood control, groundwater recharge, pollution and sediment control, as well as concerns for fish and wildlife. Generally, the decision to preserve wetlands hinges on economics--whether the cost of turning the land into profitable crops offsets the cost of draining. Minnesota recently established a state Water Bank Program and a tax credit program to encourage wetland preservation by landowners. The state water bank payments exceed federal water bank payments. Under the tax credit program, wetlands are exempt from taxation, and a credit is applied to the remainder of the property. In Minnesota, state water bank payments combined with tax credits or federal easement payments provide an economically feasible alternative to draining wetlands for agriculture.[67]

Other measures which protect wetlands include the Federal Water Pollution Control Act (or Clean Water Act) and Executive Order 11990. Section 404 of the Clean Water Act established a permit program to regulate the discharge of dredged and fill materials into all waters, including wetlands. The U.S. Army Corps of Engineers is responsible for issuing Section 404 permits. The U.S. Environmental Protection Agency (EPA) develops environmental guidelines used by the EPA, the states, and the corps to evaluate deposition of dredged

[66]Executive Office of the President, Council on Environmental Quality, Environmental Quality — 1980: the Eleventh Annual Report of the Council on Environmental Quality, December 1980.

[67]U.S. Army Corps of Engineers, Minnesota Water Planning Board, The Economics of Wetland Drainage in Agricultural Minnesota, by P.J. Farmer, January 1981. (draft)

and fill materials. Executive Order 11990 requires all federal agencies involved in development projects on federal lands to minimize the destruction or modification of wetlands, and to enhance the natural and beneficial values of wetlands.

In an attempt to assess the degradation of wetlands and preserve those remaining, the USFWS conducts the National Wetlands Inventory with the objective of inventorying, classifying, and mapping all wetlands.[68] Minnesota and Wisconsin are also currently involved in state wetland inventories with similar objectives.

Fish and wildlife management activities common to the various state agencies include fish and wildlife research, management, and planning; habitat acquisition and development; administration of wildlife and natural areas; education and technical assistance; and enforcement of regulations. The states also have programs to designate and protect species that are threatened or endangered within state boundaries.

Alternative Solutions and Effects

The major problems for fish and wildlife in the Upper Missippi Region are:

(1) Loss and degration of habitat. Fish and wildlife habitat has been lost or degraded by wetland drainage, clearing of riparian timber, sedimentation of streams and lakes, channelization, pollution, dredging and other navigation related activities.

(2) Inadequate funding for fish and wildlife programs. Fish and wildlife programs need additional funding to meet demands from fish and wildlife related recreation and protect populations from reduction or extinction.

(3) Disruption of native populations by exotic species. Exotic species have been introduced that compete for or disrupt the habitat of native species.

(4) Lead shot poisoning. Thousands of waterfowl die in the region each year by ingesting lead shot while feeding.

Habitat preservation is possible through several methods (Table II-30). Fee title acquisition is the most permanent and manageable way of preserving wetlands. Fee title acquisition has been retarded, however, because land prices have increased faster than funding. The price of the federal waterfowl stamp has been periodically raised, from $1.00 in 1934 to $7.50 in 1979. Most of the states have periodically raised their stamp prices also. Although funding from the sale of waterfowl stamps has steadily increased, it still lags behind land prices. One possible solution is for the federal and state agencies to index stamp prices to land prices. Another solution is for federal and state agencies to increase their efforts to solicit support from private agencies such as the Nature Conservancy,[69] National Wildlife Federation, and National Audobon Society to acquire wetlands, as well as other types of habitat.

Since most wetlands are in private ownership, emphasis should be placed on preservation programs which involve cooperation between landowners and government agencies. Greater participation in the federal Water Bank Program could be encouraged by increasing payments to landowners. States could institute their own water bank programs similar to the one that has been successful in Minnesota. The states could also institute tax exemption and credit programs to encourage preservation of wetlands.

Wetland preservation efforts would

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[68]The last national wetland inventory was completed in 1954 and the national map "Distribution of Wetlands of the United States according to their relative values for waterfowl within each state, 1955" (plate 21) is still the most recent. U.S. Fish and Wildlife Service, Wetlands of the United States, Circular 39, 1971.

[69]The Nature Conservancy is a unique organization that purchases quality habitat and reserves it for sale to government fish and wildlife agencies.

TABLE II-30. ALTERNATIVE SOLUTIONS TO FISH AND WILDLIFE PROBLEMS AND NEEDS: ANALYSIS AND EVALUATION[a], UPPER MISSISSIPPI REGION

Alternative Solution (Problem Addressed)	Four Account Effects				Evaluation			Conclusion
	NED	EQ	RED	DSE	Planning Objective	Efficiency	Acceptability	
(1) Accelerate the acquisition of remaining wildlife habitat, especially the fee title acquisition of high quality wetlands and critical habitats of endangered and threatened species (Loss and degradation of habitat)	- agricultural output - national cost	+ fish & wildlife habitat + groundwater quality + instream flows + natural areas + sediment control + surface water quality	+ flood damage reduction - state cost	+ aesthetics + culture + recreation	EQ,NS	High	High	Recommended
(2) Promote wetland preservation by landowners through increasing incentives for participation in water bank programs and by granting tax credits to landowners with wetlands on their property (Loss and degradation of habitat)	- agricultural output - national cost	+ fish & wildlife habitat + groundwater quality + instream flows + natural areas + sediment control + surface water quality	+ flood damage reduction + local cost - state cost	+ aesthetics + culture + recreation	EQ,NS	High	Medium	Recommended
(3) Expedite the completion of wetland surveys to assist in wetland preservation and fish and wildlife planning and management (Loss and degradation of habitat)	- national cost	+ fish & wildlife habitat + groundwater quality + instream flows + natural areas + sediment control + surface water quality	+ flood damage reduction - state cost	+ aesthetics + culture + recreation	EQ,NS	Medium	High	Recommended
(4) Enhance fish and wildlife production through the application of forest management techniques in the river basin (Loss and degradation of habitat)	- national cost + agricultural output + commercial output	+ enrosion control + fish & wildlife habitat + natural areas + sediment control + surface water quality	+ economic stability - state cost	+ aesthetics + real income + recreation	EQ,NS, NED	High	High	Recommended
(5) Increase funding for sport fish restoration and management (Inadequate funding for fish and wildlife programs)	+ commercial output + service output	+ fish & wildlife habitat	- private cost - state cost	+ aesthetics + recreation	EQ	High	High	Recommended
(6) Increase emphasis on nongame fish and wildlife research and management, especially programs involving endangered and threatened species (Inadequate funding for fish and wildlife programs)	- national cost	+ fish & wildlife habitat + natural areas	- state cost	+ aesthetics + culture + recreation	EQ,NS	High	Medium	Recommended
(7) Analyze proposed introductions of exotic species (Disruption of native populations by exotic species)	- national cost	+ fish & wildlife habitat	- state cost	+ aesthetics + recreation	EQ,NS	High	High	Recommended
(8) Restrict the use of toxic lead shot for waterfowl hunting (Lead shot poisoning)	- national cost + service output	+ fish & wildlife habitat	- private cost - state cost	+ aesthetics + recreation	EQ,NS	High	Low	Conditionally Recommended
(9) Provide the U.S. Army Corps of Engineers with more responsibility for fish and wildlife enhancement along the Mississippi River (Loss and degradation of habitat; Inadequate funding for fish and wildlife programs)	- federal cost	+ fish & wildlife habitat + natural areas + sediment control	xx	+ aesthetics + recreation	EQ	High	High	Recommended
(10) Increase research on the biological and physical features of the Mississippi River, especially to aid in determining the effects of habitat alteration (Loss and degradation of habitat)	- national cost	+ fish & wildlife habitat + natural areas + sediment control	- state cost	+ aesthetics	EQ,NS	High	High	Recommended
(11) Restore backwaters along the Mississippi River through dredging and island creation (Loss and degradation of habitat)	- federal cost	+ fish & wildlife habitat + natural areas	xx	+ aesthetics + recreation	EQ	Medium	Medium	Conditionally Recommended
(12) Reduce the effects of barge fleeting on fish and wildlife along the Mississippi River (Loss and degradation of habitat)	- national cost	+ fish & wildlife habitat + natural areas	- state cost	+ aesthetics	EQ	Medium	High	Study
(13) Minimize the effects of water level fluctuations on fish and wildlife in pools along the Mississippi River (Loss and degradation of habitat)	- federal cost	+ fish & wildlife habitat + natural areas	xx	+ aesthetics + recreation	EQ	Medium	Medium	Study
(14) Modify laws and regulations to allow creation and maintenance of interagency recommended recreation and fish and wildlife enhancement within the floodplain	- federal cost + service output	+ fish & wildlife habitat	xx	+ aesthetics + recreation	EQ	High	Medium	Recommended
(15) No action	+ agricultural output	- fish & wildlife habitat - water quality - instream flows - natural areas - sediment control	xx	- aesthetics - culture - recreation				

[a]Abbreviations in the Table: NED (National Economic Development), EQ (Environmental Quality), RED (Regional Economic Development), DSE (Other Social Effects), NS (Nonstructural), XX (Not applicable)

For complete definition of Effects, Planning Objectives, Efficiency, Acceptability, and Conclusions see Appendix E.

benefit from completion of the National Wetlands Inventory. Completion would be accelerated if the USFWS could obtain additional funding. Completion could also be accelerated if the states would institute wetland surveys. Statewide surveys would also aid in fish and wildlife planning, making permitting decisions including water resources and implementation of state water bank and tax credit programs.

Fish and wildlife production could be enhanced through the application of forest management techniques in the river basin. Increased forestry extension efforts would educate private landowners as to the values of riparian timber stands and the proper silvicultural techniques for improving such stands.

Each state and federal agency contributing to the natural resource management of the Upper Mississippi River could place more emphasis on the river by increasing staff and budget allocations to the work on the fish and wildlife resources on the river. The state management agencies, the COE and the USFWS, could develop and complete a natural history survey to identify those natural, scenic and cultural areas needing protection.

Several alternatives exist to increase funding for fish and wildlife programs. Funding for sport fish management could be increased by expanding the Dingell-Johnson Federal Aid in Sport Fish Restoration Act. The Dingell-Johnson program could be expanded by adding a 3 percent excise tax on new boat trailers, fishing size motors, and boats up to 25 feet; and by including sonar fish finders and related items under the 10 percent excise tax already covering most fishing tackle. Expansion of the Dingell-Johnson program would increase funds available for fisheries programs by $100 million annually throughout the country.[70]

Nongame fish and wildlife, especially threatened and endangered species, also need increased funding and support. One way is for Congress and the states to increase funding for nongame programs. Programs that reintroduce extirpated species are especially useful in preserving species diversity and preventing extinction. Emphasis could be directed at determining habitat use by threatened and endangered species in the Mississippi River floodplain to guide development and navigation activities.

Cost allocation programs for user/beneficiaries could be developed by appropriate agencies in managing water resources. This would ensure a broad funding base encompassing all the special interest groups engaged in consumptive or non-consumptive use of fish, wildlife, and other water resources.

A cooperative program could be instituted among federal and state agencies to analyze proposed introductions of exotic species. This program would reduce or eliminate future harmful introductions, and could perhaps identify beneficial ones.

Lead shot poisoning also could be reduced through cooperation between federal and state agencies. Every state could adopt proposed federal restrictions on the use of lead shot in areas where waterfowl are particularly susceptible to lead shot poisoning. These areas are mutually identified by the USFWS and the state agencies.

Congress could provide Corps of Engineers with definitive authority and funding to assist the Fish and Wildlife Service and states in accomplishing fish and wildlife conservation and recreation projects. State and federal agencies could seek modification of their laws and requirements to allow creation and maintenance of interagency recommended recreation and fish and wildlife enhancement within the floodplain.

Other alternatives to reduce habitat destruction on the Mississippi River require studies to gather information. Research is needed on the biological and physical features of the river, including fish and wildlife, aquatic vegetation, bottom substrates, and depth contours. Annual pool-by-pool cross section surveys could be used to develop and implement programs to rehabilitate backwaters. Several side channel alteration studies already conducted could be used to further test and refine the capability to predict the biological consequences of alterations to side channels and backwaters.[71]

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[70]American Fisheries Society, Minnesota Chapter Newsletter, Volume 4, Number 1 (February 1981).

[71]Great River Environmental Action Team, Main Report: GREAT II, Dec. 1980.

More information is also needed on the environmental effects of barge fleeting areas. A study by federal and state agencies to assess these effects could be conducted, and the results could be used to locate fleeting sites and provide mitigation measures.

Finally, a study could be conducted to determine the cumulative effects of pool water level fluctuation on fish and wildlife. This study could address the feasibility and potential effects of relocating pool control points to benefit fish and wildlife.[72]

Conclusion

Without the implementation of any alternative solutions (no action), the loss and degradation of habitat will reduce fish and wildlife populations. Wetlands have been shown to be extremely valuable for wildlife habitat and runoff storage. Since the fee title acquisition of wetlands provides the most permanent and manageable areas, this type of acquisition is recommended. Also recommended are increasing incentives for participation in water bank programs and the institution of tax credit programs. These are recommended because most wetlands are in private ownership. Also, Minnesota's Water Bank Program (with payments higher than the federal Water Bank Program) and tax exemption and credit program provide economic alternatives to draining wetlands.

The most recent national wetland survey was completed over 25 years ago. Wetland drainage and the location and types of remaining wetlands have not been accurately assessed. For these reasons, the accelerated completion of wetland surveys is recommended.

The number of anglers in the region is expected to increase substantially. The demand for sport fishery resources is expected to rise, especially near metropolitan areas. Increased funding for sport fishery programs is therefore recommended.

The implementation of programs to benefit game species have also been of benefit to nongame species. Programs specifically for nongame species have been lacking, and more information is needed to protect nongame species, especially threatened and endangered species. For these reasons, increased emphasis on nongame research and management is recommended.

Introduction of exotic species have met with varied success. Some species have been researched prior to introduction, and some have been carelessly or accidentally introduced. To better control the introduction of exotic species, increased analysis of proposed introductions is recommended.

Lead shot poisoning is a major cause of death for migratory waterfowl. The use of non-toxic lead shot is feared to cause increased crippling of waterfowl. A number of recent studies show no significant difference in the crippling rates of lead and steel shot. Since waterfowl are more susceptible to lead shot poisoning in particular areas (and at certain times of the year), the restricted use of lead shot for waterfowl hunting is conditionally recommended.

The U.S. Army Corps of Engineers is involved in many projects associated with navigation which alter fish and wildlife habitat. In order to provide more mitigation measures through the Fish and Wildlife Coordination Act, it is recommended that Congress provide the Corps with increased funding and authority for fish and wildlife enhancement.

Many of the biological and physical features of the Mississippi River are not known. Detailed information on fish and wildlife, aquatic plants, and submerged physical features is needed to guide fish and wildlife management and reduce the effects of navigation activities. For these reasons, increased biological and physical research is recommended.

A great deal of fish and wildlife habitat could be improved through the restoration of backwaters. Dredging and island creation pose several potential environmental problems. Therefore, a study is recommended to determine the feasibility and environmental considerations for restoring backwaters through dredging and island creation.

Barge fleeting areas also present problems for fish and wildlife. The environmental effects of fleeting areas are not fully known. More information is necessary to locate future fleeting sites and protect fish and wildlife. For these

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[72]Great River Environmental Action Team, A Study of the Upper Mississippi River; GREAT I Main Report, Sept. 1980.

reasons, a study is recommended to assess the environmental effects of fleeting areas.

The control of pool water levels along the Mississippi River has been both beneficial and harmful to fish and wildlife. Pool level fluctuations are often necessary for navigation. To reduce environmental problems, a study is recommended which examines the means of controlling pool levels to benefit fish and wildlife and navigation.

COMMERCIAL NAVIGATION

Current Conditions and Problems

The Upper Mississippi River System provides energy efficient transportation for the region's products and imports. The river also provides recreational opportunities and habitat for fish and wildlife. The various uses of the river, however, have resulted in numerous conflicts over management practices. Current activities necessary to maintain the navigation system and proposed activities to expand navigation facilities have been met with opposition because of effects on fish and wildlife habitat and the aesthetic qualities of the river system.

Annual maintenance of the navigation system is necessary to assure an adequate channel depth for transportation. The Mississippi and Illinois rivers carry large amounts of sediment caused by upland and streambank erosion and channel scour. Sediment deposited along the navigation channel must be dredged periodically to avoid blockages and the grounding of tows. An average 7.8 million cubic yards of material were dredged annually from the Upper Mississippi River between 1970 and 1979. Approximately 53 percent of this material was dredged from the portion below the mouth of the Missouri River. On the Illinois River, an average 1.2 million cubic yards are dredged annually.[73]

Public opposition has arisen in recent years to the effects of channel maintenance dredging and the subsequent disposal of dredged material along the Mississippi River. Dredging activities can degrade water quality by resuspending sediments and consequently damage fisheries. Dredged material disposal also damages fish and wildlife habitat. Although the short-term adverse effects are known, the long-term effects of dredging on water quality and the consequences of water quality problems on aquatic biota have not yet been determined.[74] Additional information on the effects of channel maintenance activities is needed to resolve many of the existing conflicts.

Rising demand for expanded navigation facilities has also caused conflicts over use of the river system. Concern over the potential environmental and economic effects of system expansion and over the subsequent increase in traffic has delayed facility construction.

For efficient commodity transport, the 38 locks and dams along the Mississippi, Illinois, and Kaskaskia rivers must be large enough and in adequate repair to accommodate rising traffic demands. Inadequate lock capacity is a problem primarily at Locks and Dam No. 26 near Alton, Illinois. Locks and Dam No. 26 are situated at a critical location in the inland waterway system, connecting the Ohio and Lower Mississippi rivers with the Upper Mississippi and Illinois rivers. The locks and dam, built in 1938, are in a deteriorating condition and have become costly to maintain and operate. With an increasing number of tows using the river system, delays up to 80 hours have occurred at the locks which add to shipping and consumer costs. Shipping delays particularly hurt the small farmer who does not have adequate storage capacity and must move large amounts of grain in a short time.

Terminal and fleeting space also must be available for efficient movement of commodities. Recent increases in western coal shipments and exports of midwestern grain have increased pressures on existing facilities. Deficits in cargo loading and unloading facilities in Illinois are estimated to be 29.3 million short tons for 1980. In Missouri deficits are estimated at 11.8 million short tons. Total deficits are 829,000 short tons for Iowa, 895,000 for Minnesota, and 172,000 for Wisconsin.[75] Commodities most

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[73]Personal communication with the North Central Division of the U.S. Army Corps of Engineers, May 1980.

[74]Great River Environmental Action Team, A Study of the Upper Mississippi River: GREAT I Main Report, September 1980.

[75]U.S. Department of Commerce, Maritime Administration, Mid-America Ports Study, June 1979. Since figures include port facilities in the entire state, port deficits on the Ohio and Missouri rivers are included.

affected by deficits in handling capacity are coal, grain, and agricultural chemicals. With the use of intermodal transportation systems becoming more prevalent, the demand for rail-barge transfer facilities is also increasing.

Efficient use of terminals and ports relies on adequate fleeting areas near terminals. Fleeting area shortages have occurred in several areas along the Mississippi and Minnesota rivers. Barges are often tied to trees as a result of fleeting shortages, which damages the vegetation and inconveniences barge operators. Competition for land along the river from recreation and conservation interests has made acquisition of permits for fleeting space difficult. Public opposition to fleeting near the Pikes Peak State Park in Iowa and below Pig's Eye Island in St. Paul, Minnesota, are examples of such conflicts. The process for obtaining fleeting area permits is often delayed by the lack of data for environmental assessments.

Proposals to expand the various components of the navigation system have been met with opposition from environmental interests and the railroad industry. Issues that have been raised include the need for expansion, compatability of expansion with fish and wildlife management objectives, and the effects of expansion on other modes of transportation.

Conflicts over expansion of navigation on the Mississippi and Illinois rivers cannot be resolved until the effects of traffic on fish and wildlife habitat and recreation and cultural resources have been determined. The effects of system expansion on other transportation industries and the capacity for other modes of traffic to accommodate the increasing demand for commodity movement must also be understood before decisions on navigation facilities are made.

Anticipated Problems

Changes in dredging requirements and dredged material disposal practices, increases in commodity movement, and subsequent increases in navigation demand will influence navigation issues in the future.

Some of the existing dredged material disposal conflicts will be resolved if the Army Corps of Engineers implements measures to reduce environmental effects throughout the river system. Such measures include the reduction of streambank erosion, restoration of wing dams to reduce sedimentation, using dredged materials for beneficial uses, containment of dredged materials, and disposal of material outside the floodplain. Some of these measures have been implemented within the reach of the Mississippi River above Saverton, Missouri, through the Great River Environmental Action Teams (GREATs I and II).

If these and other measures identified by the GREAT Studies are implemented throughout the region, the costs of dredging will rise. Many of the GREAT requirements were developed with inadequate consideration of additional costs incurred. This will become a major issue if additional cost recovery programs are required of the navigation industry.

Conflicts over use of the river will increase in the future as commercial navigation demand rises. Projections indicate a 74 percent increase in traffic demand for the Mississippi River above Grafton from 1980 to 2003.[76] Traffic demands on the Illinois River and the Mississippi River below Grafton are projected to increase 89 and 56 percent, respectively. However, without resolution of existing navigation conflicts, expanding traffic will be limited, both by physical constraints of existing navigation facilities and by demands from other segments of the population for use of the river.

Rising coal and grain shipments constitute most of the projected increase in traffic. Future movement of agricultural products will depend on many factors. Demand for grain transportation will be affected to a great extent by changes in foreign grain purchases, since most of the corn and soybeans currently transported on the Mississippi River are destined for foreign markets. A 71 percent increase in farm product shipments is projected for the Upper Mississippi River by the year 2020.

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[76] U.S. Army Corps of Engineers, National Waterways Study, Traffic Forecasting Methodology and Demand Projections, April 1980. (review draft)

Future energy policies will influence coal and petroleum shipments. Since the recent oil shortage, energy policy has encouraged greater use of domestic coal, which has increased demand for coal transportation. Current environmental regulations restricting power plant sulfur emissions have resulted in greater downstream movement of low-sulfur western coal and, as a result, less transport upstream of Illinois-Kentucky coal. However, future environmental regulations or technological developments could encourage use of southern coal by easing sulfur restrictions. Movement of southern coal to upstream processing plants could also occur for synthetic oil and gas production. Although rising electricity demand will increase fuel shipments, effective energy conservation programs and use of alternative energy sources would slow the rate of increase. Coal movement is projected to increase 143 percent from 1980 to 2003 on the reach of the Mississippi River above the mouth of the Missouri River and 277 percent on the reach between the Illinois and Missouri rivers.

Although the demand for navigation will most likely increase significantly in the future, limited lock capacity will constrain traffic growth without facility expansion. Updated projections are necessary, though, to predict which locks will be affected and when capacity will be reached.

Terminal facility and fleeting area shortages will also limit navigation growth. Deficits in cargo handling capacity in Illinois, Iowa, Minnesota, Missouri, and Wisconsin are projected to be 130 million short tons by 2000.[77] Costs for developing the necessary facilities are estimated at $1.27 billion. If a coordinated system of larger facilities is developed, costs could be reduced to approximately $1.18 billion. A lack of waterfront land for terminal facilities will be a problem in the future as competition for such land from recreational and other commercial interests increases.

In most cases increased traffic will result in a more efficient use of existing facilities such as double shifts at terminals, average tow sizes closer to maximum pair and 15 barges, and quicker turn around at fleeting areas. Locating sites for new fleeting areas will be a problem, however, as demands for fish and wildlife habitat, recreation lands, and fleeting areas increase. Although fleeting areas are most efficient when located in the same pool as terminals, scarce land resources may force fleeting areas to less desirable locations. Problems with fleeting area permit delays will continue unless their effects on endangered mussels and other fish and wildlife species are identified.

The region's major navigation problems concern the current channel maintenance activities and the rising demand for system expansion. A lack of information for determining the effects of current and proposed activities and the conflicting management goals for the river system have impaired the economic and environmental functions of the river system. Until the effects of dredging, dredged material disposal, barge traffic, lock expansion, and port and fleeting area development are ascertained, conflicts on use and development of the Upper Mississippi River System will continue.

Governmental Authority, Responsibility, and Policy

The U.S. Congress has delegated management authority for the Upper Mississippi River to the Army Corps of Engineers for maintaining commercial navigation and to the U.S. Fish and Wildlife Service for managing fish and wildlife. These two management objectives along with several other state and federal programs have resulted in a complex and often conflicting set of laws, rules, and regulations governing improvement and maintenance operations for the Upper Mississippi Navigation System (Table II-31).

The U.S. Army Corps of Engineers is the primary agency responsible for the development and maintenance of inland waterways. The Army Corps of Engineers constructs, maintains, and operates federal river and harbor projects. In addition, the Army Corps of Engineers protects navigable waters through permits for construction and operation of structures over or in navigable waters; by

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[77]U.S. Department of Commerce, Maritime Administration, op. cit., footnote 75.

TABLE II-31. GOVERNMENTAL AUTHORITY AND RESPONSIBILITY FOR COMMERCIAL NAVIGATION, UPPER MISSISSIPPI REGION

Agency		Authority[a]	Primary Program (function)
		U.S. GOVERNMENT	
DEPARTMENT OF THE ARMY			
Corps of Engineers	I	May 24, 1824	(construction and maintenance of navigation system)
	R,E	River and Harbor Act of 1899	(establishes harbor lines, issues permits for construction in or over navigable waters and for excavating from or depositing or discharging material in navigable waters, removes channel obstructions)
	S	P.L. 67-362, Sec. 11, Sept. 1922	(compiles annual statistics on vessels, passengers, freight, and tonnage utilizing the waterway)
	I	River and Harbor Act of 1945 (Sec. 3) P.L. 79-14	Protection, Clearing, and Straightening of Channels
	I	River and Harbor Act of 1950 (Sec. 107), as amended; P.L. 86-645	Small Navigation Projects
	R	Clean Water Act of 1977 (Sec. 404)	(issues permits for the disposal of dredged or fill material in navigable waters and tributaries in compliance with EPA guidelines)
DEPARTMENT OF COMMERCE			
Maritime Administration	S	Merchant Marine Act of 1920 (Sec. 8) P.L. 66-261, as amended	(development and promotion of ports and intermodal transportation)
	S	Merchant Marine Act of 1936 (Sec. 101) P.L. 91-469, as amended	(development and promotion of domestic waterbourne transport systems)
DEPARTMENT OF THE INTERIOR			
Fish and Wildlife Service	S,R	Fish and Wildlife Act of 1956; Fish and Wildlife Act of 1974	(analyzes federal projects to ensure conservation and management of fish and wildlife resources, issues permits for fleeting areas)
	S	Endangered Species Act of 1973	Conservation of threatened and Endangered Species - Section 7 (Consultation and issuance of a biological opinion to federal agencies authorizing or funding water resources projects)
DEPARTMENT OF TRANSPORTATION			
Transportation Systems Center	S	Act of October 15, 1966, P.L. 80-931	(research on the economic and environmental resources, institutional characteristics, and transportation technology of the national transportation system)
Transportation Programs Bureau	S	Act of October 15, 1966, P.L. 80-931	(programs concerning transportation safety, security, facilities, technology, and communications)
U.S. Coast Guard	S,R,E,I	Act of January 28, 1915	(commercial vessel safety legislation enforcement, navigation accident investigations, implements and maintains aid to navigation, search and rescue operations, ice-breaking operations, port and harbor protection, oil spill clean up, and alteration or removal of obstructive bridges)
	S	Federal Boat Safety Act of 1971, P.L. 85-911	Boat Safety Program (recreational craft safety standards, boat safety courses and boat safety manuals)
	E	Ports and Waterway Safety Act of 1972 (P.L. 92-340 and P.L. 95-474)	Commercial Vessel Safety (boat safety authority during emergencies)
	R	Clean Water Act of 1977 (Sec.311,312)	(regulates discharge of hazardous substances from vessels)
ENVIRONMENTAL PROTECTION AGENCY	R	Clean Water Act of 1977 (Sec. 404)	(regulates disposal of dredged or fill material into navigable waterways and tributaries, supervises state dredge permit programs)
	R	Clean Water Act of 1977 (Sec. 311,312)	(regulates effluent discharges from vessels and discharges of hazardous substances)
NATIONAL TRANSPORTATION BOARD	S	Independent Safety Board Act of 1974 (88 Stat. 2156; 49 U.S.C. 1901)	(investigates major navigation accidents)
		ILLINOIS	
DEPARTMENT OF TRANSPORTATION			
Division of Water Resources	S,R,I	IL Statutes, Chapters 19 and 127	(plans, develops, and maintains the state's navigation system, issues permits for construction or activities in public waters or on floodplain)
ENVIRONMENTAL PROTECTION AGENCY	R	IL Statutes, Chapter 111	(regulates dredged materials disposal, sets water quality standards)
REGIONAL PORT DISTRICTS	S,I	-----	(public bodies created by acts of the General Assembly to plan, develop, operate, and promote water ports and other transportation facilities)
		INDIANA	
DEPARTMENT OF NATURAL RESOURCES			
Division of Water	S,R,I	IND Statutes	(plans, develops, and regulates navigation facilities)

TABLE II-31. (Continued)

Agency	Authority[a]		Primary Program (function)
		IOWA	
CONSERVATION COMMISSION	R,E	IA Statutes, Chapters 474 and 476A	(adopts and enforces navigation and water safety laws, registers and inspects boats; regulates the removal of materials from state-owned lands and waters)
DEPARTMENT OF ENVIRONMENTAL QUALITY Water Quality Commission	R,E	IA Statutes, Chapter 455B	(sets water quality standards, regulates dredging activities according to standards)
DEPARTMENT OF TRANSPORTATION	S,R,I	IA Statutes, Chapter 306 (Section 306.27 and Chapter 307 (Section 307.25)	(manages the adequacy, safety, and efficiency of transportation facilities)
NATURAL RESOURCES COUNCIL	R,S	IA Statutes, Chapter 455A	(issues permits for any structure, dam, obstruction, deposit, or excavation in or on any floodway; coordinates and investigates navigation and other water resources projects)
		MINNESOTA	
DEPARTMENT OF NATURAL RESOURCES	R	MN Statutes, Chapter 105	(regulates dam construction, dredging operations, disposal of dredged materials, and water surface use)
DEPARTMENT OF TRANSPORTATION	S	MN Statutes, Chapter 174	(conducts planning, regulation, and development of ports in cooperation with local port districts)
POLLUTION CONTROL AGENCY	R	MN Statutes, Chapter 115	(issues permits for discharges into state waters, including dredged material disposal, enforces water quality standards)
		MISSOURI	
DEPARTMENT OF PUBLIC SAFETY	R,I	Omnibus Reorganization Act of 1974	(recreational boat registration and safety regulations, equipment standards, maintains navigation markers)
HIGHWAYS AND TRANSPORTATION DEPARTMENT			
Division of Waterways	S,R,I	Omnibus Reorganization Act of 1974	(plans, promotes, and develops a balanced multi-modal transportation system, sets state transportation policy)
		WISCONSIN	
DEPARTMENT OF DEVELOPMENT	S	WI Statutes, Chapter 560	(formulates, coordinates, and directs a state port development program, collects and disseminates information on waterfront development and freight rates, and promotes new port-related business)
DEPARTMENT OF NATURAL RESOURCES	R,E	WI Statutes, Chapter 30	(issues permits for discharges into state waterways, removal of material from a navigable stream, placement of obstructions in navigable waters or floodway, and stream alterations)
DEPARTMENT OF TRANSPORTATION	S,F	WI Statutes, Chapter 85	(directs the use of and expends state and federal funds for planning, promotion and protection activities for all transportation modes and for assistance in harbor construction)

[a]Scope of authority is defined as follows:
S= Statutory: research, collect information, coordinate, prepare plans
R= Regulatory: establish rules and regulations, issue permits
E= Enforcement: enforce laws and regulations
I= Implementation/Construction: administer funds, acquire land, construct and operate projects

Sources: Executive Office of the President, Office of Management and Budget, 1979 Catalog of Federal Domestic Assistance, May 1979.
U.S. Department of the Army, Corps of Engineers, Digest of Water Resources Policies and Authorities, September 1979.
Upper Mississippi River Basin Commission, FY 1978 Program Report of State and Federal Water and Related Land Resources Efforts, December 1978.
Upper Mississippi River Basin Commission, Upper Mississippi River Main Stem Level B Study, Technical Paper G: Legal and Institutional, August 1979. (draft)
Stewart, Suzan M., State and Federal Restrictions on Dredge Spoil Placement in the Upper Mississippi River Area, Iowa Geological Survey, May 1978.

removing sunken vessels or other obstructions endangering navigation; and by establishing anchorage grounds, danger zones, dumping grounds, restricted areas, and harbor lines.

Under Section 404 of the 1972 Water Pollution Control Act Amendments, the Corps of Engineers operates a permit program for discharges of dredged or fill material into navigable water ways.[78] Although the amendment authorized the states to operate the federal permit program with consultation by the Environmental Protection Agency and the Fish and Wildlife Service, none of the states have assumed this role.

The U.S. Coast Guard of the Department of Transportation is concerned with

[78]Navigable waterways were subsequently defined as all navigable waters, their tributaries, and adjacent wetlands.

navigation safety on inland waterways. The Coast Guard ensures a safe, unobstructed navigation channel by implementing navigation aids such as buoys and channel markers, enforcing commercial vessel safety regulations, and regulating bridge placement and operation.

The Maritime Administration of the Department of Commerce and the National Transportation Board are also involved with navigation facility planning and safety.

State activities affecting navigation include facilities planning, safety regulations, and discharge and dredging regulations. Numerous state and local programs affect dredging and dredged material disposal activities. Section 404(t) of the Clean Water Act Amendments of 1977 requires federal compliance with state dredging programs. Illinois, Iowa, Minnesota, and Wisconsin have established programs requiring permits for the disposal of dredged materials.

State water quality programs also affect dredging operations. Under Section 303 of the Clean Water Act, states establish water quality standards, and, under section 401 of the act, states certify that federally permitted or licensed activities will comply with the standards.

In Iowa specific effluent standards for dredging have not been established, but existing turbidity and dissolved solids standards affect dredging operations. Under section 401, the Iowa Department of Environmental Quality reviews dredging operations. Minnesota and Wisconsin certifies discharges into state waters under Section 401 and oppose open water disposal of dredged materials. The Illinois Environmental Protection Agency has waived certification under Section 401 for most dredging operations. However, as water quality standards applicable to dredging are established in the future, certification will be required. Missouri does not require certification with state water quality standards.[79]

Dredging operations may also conflict with local floodplain management programs. Most of the counties along the Mississippi and Illinois rivers have floodplain zoning in effect, which may restrict dredged material disposal activities that significantly raise flood stages. In Wisconsin, placement of dredged material is prohibited in the floodway and only allowed in the floodway fringe if it is compatible with local plans and does not increase the regional flood height by more than 0.1 feet. In Minnesota, dredged material disposal in the floodway is prohibited. In Illinois and Iowa, any activities in the floodway which would increase flood heights are prohibited.[80]

Disposal of contaminated material is restricted by solid waste regulations. According to the 1976 Resource Conservation and Recovery Act, dredged materials contaminated with hazardous substances must be disposed of in contained placement sites.

In addition to state and federal programs, several interagency efforts are currently addressing navigation problems. The Great River Environmental Action Team I (GREAT I) was formed in 1974 to evaluate alternatives for managing, preserving, and restoring Mississippi River resources. GREAT I consists of representatives from the Army Corps of Engineers, the U.S. Fish and Wildlife Service, the Department of Agriculture, the Environmental Protection Agency, and the U.S. Coast Guard, and representatives from state agencies. The GREAT I study area extends from the head of navigation at Minneapolis to Lock and Dam 10 at Guttenberg, Iowa. Since then similar study teams have been established for the portion of the Upper Mississippi River from Guttenberg to Lock and Dam 22 at Saverton, Missouri (GREAT II), and the portion from Saverton to the mouth of the Ohio River at Cairo, Illinois (Great River Resources Management Study-GREAT III). Final reports have been completed by GREAT's I and II, including channel maintenance plans with interim and long-term recommendations for each dredge cut along the river. The

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[79]Upper Mississippi River Basin Commission, Symposium Proceedings, Dredging: The Challenge, the Technology, the Opportunity, January 1979.

[80]Great River Environmental Action Team, State and Federal Restrictions on Dredge Spoil Placement in the Upper Mississippi River Area, by Suzan M. Stewart for the Dredged Material Uses Work Group, May 1978.

GREAT III activities were initiated in 1978 and should be completed by 1984.

In October 1978, President Carter signed P.L. 95-502 which authorized initiation of a Comprehensive Master Plan for Management of the Upper Mississippi River System (Master Plan) by the Upper Mississippi River Basin Commission (UMRBC). The Master Plan is identifying economic, recreational, and environmental objectives for the river system, utilizing results from the GREAT studies, and recommending guidelines to achieve such objectives. Specific studies are being conducted to determine the effect of navigation expansion on the environment and on other transportation industries and the relationship of navigation expansion to national transportation policy. The UMRBC is also analyzing the costs and benefits of placing dredged material out of the floodplain and conducting a feasibility study for a computerized analytical inventory to facilitate evaluation of alternative management proposals.

Alternative Solutions and Effects

The major problems facing navigation are:

(1) System capacity. As a result of inadequate lock capacity existing traffic is delayed, primarily at Lock and Dam 26. Future demand for navigation will not be met without increases in system capacity.

(2) Navigation safety. Hazardous conditions on the river cause collisons and accidents involving commercial and recreational traffic.

(3) Fleeting and terminal areas. Insufficient terminal and fleeting facilities resulting from delays in the permitting process, lack of environmental data, and competing land uses constrain navigation growth.

(4) Channel maintenance. Increasing regulations to prevent the adverse effects of channel maintenance is causing the costs of channel maintenance to rise.

Alternatives addressing navigation system capacity include: (1) enlarging current locks, (2) constructing additional locks, (3) deepening the nine-foot channel to twelve feet, (4) limiting increases in navigation facilities, (5) improving navigation efficiency, and (6) expanding the navigation season (Table II-32). Continuing enlargements of locks or building additional locks to accomodate maximum demand for navigation would have additional effects on fish and wildlife habitat and water quality. Studies are currently underway through the Master Plan Study to determine effects on the river system.

A deeper channel would permit larger cargo loads, but is considered environmentally unacceptable. Limiting increases in navigation traffic would maintain environmental resources, but delays at locks and transportation costs would increase. Traffic would be diverted to less safe and less energy efficient modes of transportation with subsequent environmental effects.

Navigation efficiency could be improved through measures such as traffic control scheduling, helper boats at locks, and better equipment scheduling to avoid movement of empty barges. Improved efficiency measures would increase the navigation capacity without altering the lock system. Environmental effects would be minimal under this alternative. The economic feasibility of this alternative is being evaluated by the Master Plan Study. Providing average lock processing times to the barge and towing industry for use in training barge crews would improve the efficiency of lock operations.

A season extension to 52 weeks was evaluated by the Army Corps of Engineers for the river stretch between Grafton, Illinois, and Burlington, Iowa, and a 40 week season for the stretch between Burlington and Cassville, Wisconsin. The 40 week season was found to be economically feasible, but because of a lack of information on environmental effects it is not justifiable at this time.[81]

Increasing safety for navigation would reduce transportation costs and

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[81]U.S. Army Corps of Engineers, Mississippi River Year Round Navigation Study, Stage 2 Feasibility Report, November 1980.

TABLE II-32 ALTERNATIVE SOLUTIONS TO COMMERCIAL NAVIGATION PROBLEMS AND NEEDS: ANALYSIS AND EVALUATION[a], UPPER MISSISSIPPI REGION

Alternative Solution (Problem Addressed)	Four Account Effects				Evaluation			
	NED	EQ	RED	OSE	Planning Objective	Effi-ciency	Accept-ability	Conclusion
(1) Expand lock capacities to accommodate projected commerce needs (System capacity)	- federal cost + navigation + non-agricultural output	- fish & wildlife habitat - natural areas - surface water quality	+ jobs + economic stability	- aesthetics + emergency preparation	NED	High	Medium	Study
(2) Construct additional locks to accomodate commercial or recreational craft (System capacity)	- federal cost + navigation + non-agricultural output	- fish & wildlife habitat - natural areas - surface water quality	+ jobs + economic stability	- aesthetics + emergency preparation	NED	medium	Medium	Study
(3) Increase the depth of the authorized navigation channel from 9 feet to 12 feet to increase capacity of the navigation system (System capacity)	- federal cost + navigation + non-agricultural output	- fish & wildlife habitat - natural areas - surface water quality	+ jobs + economic stability	- aesthetics + emergency preparation	NED	Medium	Low	Not Recommended
(4) Restrict future development of navigation facilities and limit commercial waterway traffic to assure environmental compatability (System capacity)	- navigation	+ fish & wildlife habitat + natural areas + surface water quality	- economic stability	- real income + recreation + aesthetics - emergency preparation	EQ,NS	Low	Medium	Not Recommended
(5) Implement efficiency measures to increase capacity of the navigation system (System capacity)	- federal cost + navigation + non-agricultural output	xx	+ jobs + economic stability	+ recreation + real income	NED,NS	Medium	High	Recommended
(6) Extension of the commercial navigation season into winter months (System capacity)	- federal cost + navigation + non-agricultural output	- fish & wildlife habitat - surface water quality	+ jobs + economic stability	+ real income	NED	Medium	Low	Not Recommended
(7) Increase safety measures for commercial and recreational traffic traffic (Navigation safety)	- federal cost + navigation	xx	+ economic stability	+ health and safety	NED	High	High	Recommended
(8) Develop terminals and fleeting areas required for existing and future traffic (Fleeting and terminal areas)	- national cost + navigation + industrial output + commercial output	- fish & wildlife habitat - natural areas	+ economic stability + jobs - private cost	- aesthetics + real income	NED	High	Medium	Conditionally Recommended
(9) Develop an inter-agency management team to coordinate the activities of state and federal agencies affecting the river system (System capacity, Fleeting and terminal areas, Channel maintenance)	- national cost + navigation	+ fish & wildlife habitat + natural areas + surface water quality + erosion control + sediment control	- state cost + economic stability + flood damage reduction	+ aesthetics + health and safety	NED,EQ	High	High	Recommended
(10) Reduce dredging requirements and subsequent disposal problems by limiting the depth of dredging (Channel maintenance)	+ navigation	+ fish & wildlife habitat + surface water quality + erosion control + sediment control	xx	+ aesthetics	EQ,NS	Medium	High	Conditionally Recommended
(11) Donate or sell dredged material for productive uses to prevent problems resulting from disposal of materials in the floodplain (Channel maintenance)	- federal cost + navigation + commercial output + industrial output	+ fish & wildlife habitat + natural areas + surface water quality + sediment control	xx	+ aesthetics	EQ,NS	High	High	Conditionally Recommended
(12) Maintain the navigation channel to meet current and future needs of commercial navigation consistent with other resource requirements (Channel maintenance)	- federal cost + navigation	+ fish & wildlife habitat + natural areas + surface water quality + sediment control	+ flood damage reduction	+ aesthetics	EQ,NS	Medium	High	Recommended
(13) No action (No expansion of the navigation system and continued disposal of dredged materials in open water and backwater areas)	- navigation	- fish & wildlife habitat - natural areas - surface water quality - sediment control	- jobs - economic stability - flood damage reduction	- aesthetics	-	Low	Low	Not Recommended

[a]Abbreviations in the Table: NED (National Economic Development), EQ (Environmental Quality), RED (Regional Economic Development), OSE (Other Social Effects), NS (Nonstructural), XX (Not applicable)

For complete definition of Effects, Planning Objectives, Efficiency, Acceptability, and Conclusions see Appendix E.

improve conditions for commercial and recreational craft. The Great River Environmental Action Teams (GREAT's I and II) identified measures to increase safety. Additional funding for the U.S. Coast Guard navigation aids program would enable the Coast Guard to employ additional personnel to maintain channel markers, to improve sounding equipment for the placement of buoys, and to cooperate with boaters and the Army Corps of Engineers to identify hazards. The Coast Guard could also evaluate vessel lighting requirements for means to improve safety.[82]

Much of the conflicts between commercial and recreational vessels result from congestion at locks and dams. The Army Corps of Engineers could establish specific locking times for recreational craft and post such times at locks to reduce the number of boats waiting at lock areas. Modifying or marking river control structures, such as wing and closing dams, would also improve safety, since approximately 18 percent of the recreational boating accidents in the GREAT I study area occur from hitting these types of objects.[83] Increased funding for the Army Corps of Engineers and the Coast Guard to monitor hazardous areas and eliminate hazards would improve conditions for recreational and commercial vessels. Construction of auxiliary locks for recreational craft is being evaluated by the Army Corps of Engineers.

GREAT's I and II both recommended changes in regulation of bridge operations. Providing civil penalties for violations would increase compliance with regulations and reduce bridge related accidents. Navigation aids could be implemented by the Coast Guard to increase visibility of bridge piers. The GREAT reports also recommended the Truman-Hobbs Act, which provides funds for rebuilding obstructive bridges, be amended to allow repair of bridge protection systems.

Expansion of terminal facilities and fleeting areas is another alternative to optimize commercial use of the inland waterway. However, uncontrolled development of such facilities would create conflicts with recreational and environmental interests. To minimize conflicts, local and regional planning agencies could coordinate terminal development and encourage aggregated facilities, which would reduce infrastructure costs and conserve acreage for recreation and other land use interests. Although an additional $1.3 billion in facilities will be needed by 2000 for Illinois, Iowa, Minnesota, Missouri, and Wisconsin, this cost could be reduced by $82 million and 227 acres of riverfront land could be saved by clustering facilities.[84]

Developing additional rail to barge transfer facilities at terminal areas would promote more efficient use of the region's intermodal transportation system and subsequently reduce shipping costs. A rail-barge network in the region would serve a greater area than the traditional truck-barge network. To encourage intermodal transportation, rail service and highway volume and load capacity at port areas could be increased.

Development of additional fleeting areas has been hindered by conflicts over location, size, and their effects on recreation and fish and wildlife habitat. A comprehensive study of fleeting needs along the river could be conducted to identify areas of greatest demand. Land use plans designating portions of riverfront land for recreation, conservation, and fleeting purposes could subsequently be developed to encourage aggregation of fleeting areas and to avoid future conflicts with other interests. Additional research on the effects of fleeting areas on fish and wildlife would facilitate the permit process, reduce delays, and identify means to lessen adverse effects.

Development of additional ports and fleeting areas is primarily a private responsibility. However, state governments can establish local port districts for promoting private investment. In Wisconsin local boards of harbor commissioners serve a similar purpose as port districts, but do not have independent bonding authority.

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[82]Great River Environmental Action Team, A Study of the Upper Mississippi River: GREAT I Main Report, September 1980. Great River Environmental Action, GREAT II Main Report, December 1980.

[83]Great River Environmental Action Team, op. cit., footnote 74.

[84]U. S. Department of Commerce, Maritime Administration, op. cit., footnote 75.

Port districts can coordinate development to reduce land use conflicts, plan for intermodal facilities, and resolve conflicts within the community over port development. Port districts can also develop and operate public terminal and port facilities and initiate requests for federal harbor projects. Current projects include a commercial harbor proposal by the Army Corps of Engineers and feasibility studies for construction of port facilities in Jefferson County and Mississippi County, Missouri (Figure II-24). A project to reduce sedimentation in the St. Louis Harbor is also proposed by the Army Corps of Engineers. Identification of additional harbors with sedimentation problems would increase harbor accessibility.

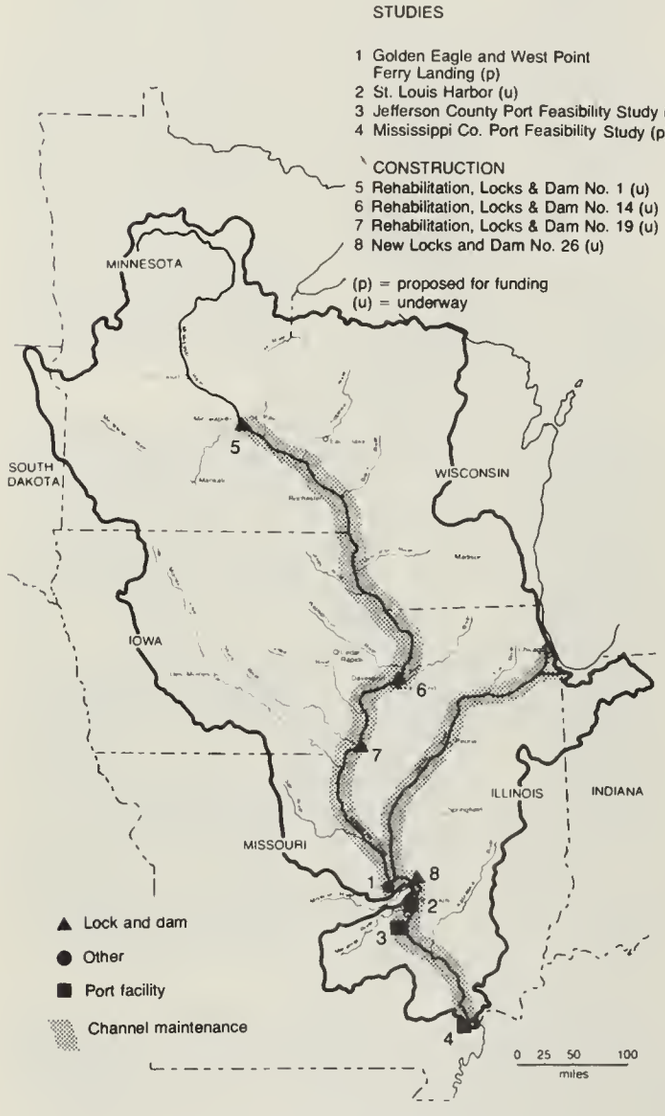

FIGURE II-24. POTENTIAL AND UNDERWAY COMMERCIAL NAVIGATION PROJECTS, UPPER MISSISSIPPI REGION

Source: UMRBC, *FY1983 Annual Priorities Report*, June 1981.
U.S. Army Corps of Engineers, *Water Resources Development in Illinois*, 1979; *Water Resources Development in Indiana*, 1979; *Water Resources Development in Iowa*, 1979; *Water Resources Development in Minnesota*, 1979; *Water Resources Development in Missouri*, 1979; *Water Resources Development in Wisconsin*, 1979.

Establishment of an inter-agency coordination team, composed of representatives from state and federal agencies concerned with river management, could address problems over use and development of the river. The Great River Environmental Action teams have initiated studies on fleeting needs, dredged material disposal, and other needs and have identified means to reduce many existing problems. Continuation of an interagency management team would ensure additional cooperation in the identification of problems and potential solutions and the implementation of feasible solutions.

Many of the conflicts over channel maintenance operations could be reduced by implementation of alternative dredging and dredged material disposal practices. However, some of these alternative practices have been implemented and have caused conflicts over excessive costs, vessel safety, and channel reliability.

By reducing dredging requirements the adverse effects of dredged material disposal and the high costs of using alternative measures would be prevented. Limiting the depth of dredging at some sites can reduce dredged material volume. Since initiation of the GREAT I Program in 1975, dredging has been restricted to eleven or twelve feet at twenty-four sites along the Mississippi River without significantly increasing dredging frequency. Reduced depths, however, can seriously affect a vessel's fuel efficiency and manuevering ability. An interagency review committee including representatives from the Army Corps of Engineers and the U.S. Coast Guard could be established to identify sites for reduced depth dredging in the future and to ensure the safety of such operations.

Optimum dredging depths could be determined through the use of computerized sediment transport models. Sediment transport has been successfully estimated through one and two-dimensional models developed for portions of pools 4 through 8 by the GREAT I study. Developing a two dimensional model for application throughout the river system could be used to determine dredging depths, possible changes to wing dams, and other means to reduce dredging requirements.

Finding beneficial uses for dredged material would also prevent disposal problems. Legal studies conducted through the Master Plan indicate that the Army Corps of Engineers can sell dredged materials, under certain conditions, to sand and gravel companies or donate material to other government agencies or non-profit organizations.[85]

Placement of dredged material in accessible locations would allow its use for landfill, concrete, road sanding, and levee maintenance. GREAT I found a potential demand for 70 percent of the available dredged material.[86] However, meeting all the demand for dredged material may not be economically feasible because of transportation costs and the requirement to time demand with dredging frequency. Allowing sand and gravel companies to conduct dredging would reduce transportation and disposal costs.

Where limited depth dredging and beneficial uses cannot eliminate the need for dredged material disposal, funding for alternative measures to maintain the nine-foot channel would reduce conflicts with fish and wildlife management objectives.

Advanced planning for material disposal and onsite evaluations to identify alternative disposal sites and the most economical means to protect environmental resources would minimize future conflicts. Long-range disposal site planning would provide for environmental protection and reduce the cost of mitigation measures.[87] Planning for dredged material disposal should include development plans for each site for preventing erosion and enhancing recreation and fish and wildlife habitat.

Alternative placement sites were identified in the GREAT I & II Channel Maintenance Plans for each dredge cut. Alternatives considered include contained sites, central disposal sites, and removal of the material outside the floodplain. The cost of transporting the material is a problem with centralized sites or removing the material from the floodplain. Alternative means of transporting material are being evaluated through the Master Plan.

Riverine disposal, or open water disposal, was not evaluated by the GREAT studies. This alternative may have less effects on fish and wildlife habitat than alternatives that require backwater areas for disposal, because the sediments may remain in the main channel. The exact destination of materials deposited in open water, however, is not adequately understood and needs further study.

Many of the alternative disposal sites recommended by GREATs I and II are currently being used. The channel maintenance plan developed through GREAT I, however, is not currently acceptable to all interests because of economic and safety considerations. Interim guidelines for material disposal developed through the plan could be utilized until conflicts are resolved. Interim guidelines call for inspection of disposal sites by an interagency on-site inspection team, placement of material at beneficial use sites, use of existing sites where alternative sites are unavailable and provided re-erosion is prevented, and the use of privately owned dredging equipment where Army Corps of Engineer equipment is inadequate.[88] Where specific disposal sites are not acceptable or unavailable, temporary sites identified through the plan could be utilized.

With all floodplain or open water disposal sites, increased water quality monitoring during dredging and disposal activities would enable the Army Corps of Engineers and the states to better predict the effects of various methods and types of equipment on water quality. With additional monitoring the states would be better able to set water quality standards for dredging operations.

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[85]Upper Mississippi River Basin Commission, Dredged Material Disposal: The Issue of Competition Between Government and Private Enterprise, by Bernadine Feller McGuire for the Comprehensive Master Plan for Management of the Upper Mississippi River System, September 1980.

[86]Great River Environmental Action Team, GREAT I Dredged Material uses Appendix, September 1980.

[87]U.S. Department of the Army Corps of Engineers Waterways Experiment Station, Information Exchange Bulletin, Dredged Material Research Program Final Summary, vol. D-79-2, June 1979.

[88]Great River Environmental Action Team, op. cit., footnote 74.

Although alternative dredging practices would improve fish and wildlife habitat and water quality and minimize dredging requirements in the future, present equipment and funding levels limit their feasibility. The Army Corps of Engineers would need to augment their equipment or contract with private companies to utilize many of the alternative sites recommended in the GREAT Studies.

The GREAT I Study recommended that the COE maintain sufficient equipment to perform emergency dredging, while contracting other dredging to private companies. In order to maintain the nine-foot channel, alternative dredging and disposal methods are often not feasible in emergency situations. An acceptable definition of emergency dredging needs to be determined by the COE and states so that the channel can be freed of obstructions without conflicts from regulating agencies. The GREAT studies have developed definitions of emergency dredging which could be adopted by the COE to prevent future conflicts.

Conclusion

Without additional data on the environmental and economic effects of navigation and identification of goals and objectives for the system (no action), conflicts over use and expansion of the river system will continue. Without adoption of measures to reduce dredging requirements and disposal impacts, damage to water quality and fish and wildlife habitat will continue.

Increasing the depth of the navigation channel to twelve-feet and extending the navigation season were not recommended because of adverse environmental effects and lack of economic feasibility. Restricting navigation facility development is also not recommended because delays in traffic and transportation costs would increase and traffic would be diverted to less energy efficient modes. Expansion of the locks and construction of additional locks are recommended for further study because additional data on navigation demand and effects of expansion is needed.

Development of additional terminals and fleeting areas is recommended contingent upon assessments of environmental effects and measures to mitigate effects. Planning of such facilities to minimize land use conflicts would be necessary before implementation.

Reducing dredging requirements and finding beneficial uses for dredged material are recommended provided they are cost-efficient. Where these alternatives are not practical, dredging and material disposal methods that maintain the channel but reduce environmental effects are recommended. GREAT's I and II identified specific methods to attain this goal. Since alternative dredging and disposal measures are more costly than traditional methods, additional funds would be required for implementation.

Advanced planning by the Army Corps of Engineers to determine impending capacity problems at locks and dams is recommended to allow for adequate environmental and economic evaluation of alternative means to increase capacity. Establishment of a continuing interagency team to coordinate management of the river is recommended because it would facilitate resolution of many of the existing conflicts over use of the river.

Efficiency measures to increase system capacity are recommended, although they may only partially solve the capacity problem. Measures to increase safety are also recommended because of the benefits to navigation and the environment. Additional funding to increase safety would be necessary, however.

Current Conditions and Problems

Energy production in the region relies on coal and nuclear steam-electric generation, both of which are large water users. Hydroelectric facilities and small internal combustion and combustion turbine plants supplement steam-electric generation. Renewable non-water consumptive energy resources are not well developed with the exception of hydropower. However, increasing amounts of solar, biomass, small-scale hydropower, and combustion of solid wastes will boost regional energy production but cannot be expected to make major short-term contributions. Any shifts in the current energy situation will be in direct response to tightening petroleum supplies which could lead to further development of the gasohol and coal conversion industries.

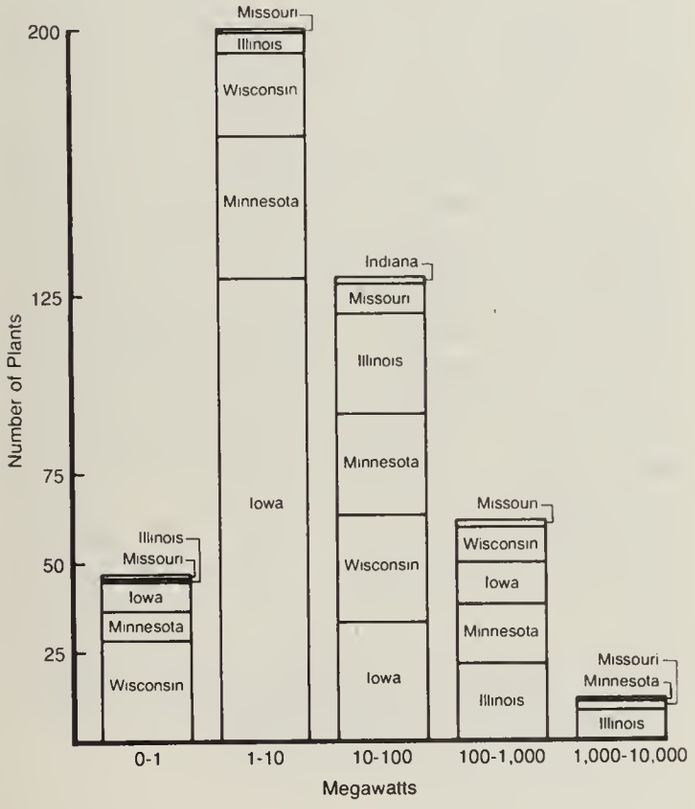

FIGURE II-25. STEAM-ELECTRIC POWER PLANTS BY SIZE AND STATE SHARE, UPPER MISSISSIPPI REGION

Source: Federal Power Commission, *Principal Electrical Facilities*, 1977.

Steam-electric generation is the largest water user in the region and the primary energy facility. Most plants are 1-10 megawatts (MW) with the fewest plants in the 1,000-10,000, MW range (Figure II-25). Most of the smaller plants are concentrated in Iowa and the few largest plants are in Illinois.

Steam-electric plants are sited on the major rivers or lakes in the region that can meet their large water requirements. The use of non-water consumptive energy sources could reduce some of the stress that full development of steam-electric generation could place on water resources.

Steam-electric plants using steam turbines to generate electricity from fossil or nuclear fuels produce most of the electrical energy and require extensive cooling systems. Power plant cooling systems, especially once-through cooling, use large volumes of water to disperse waste heat. Section 316 of the Clean Water Act of 1977 limits thermal discharges into public waters which effects cooling methods employed in new power plants. Cooling ponds and wet towers, both acceptable under this section, which calls for the use of "best available technology", will result in greater water reuse but higher consumption rates than widely used once-through cooling systems.

More efficient water use can be achieved by increasing power plant efficiency. Increased efficiency (average plant is 30-35 percent efficient) by cogeneration could reduce water consumption significantly. Steam-electric plant efficiency is directly related to the amount of water consumed and energy wasted in the form of heat. Cogeneration rechannels the energy of waste heat to steam or hot water which can fulfill the process heating requirements of local industry and the domestic sector. Heating the domestic sector (district heating) can increase steam-electric plant efficiency and utilize coal rather than fuel oil.

Throughout the region, district heating systems were once an integral part of small community steam-powered electrical cogeneration facilities. As larger electrical generators came on-line most of the cogeneration capability was

abandoned as maintenance costs and operating inefficiencies increased. Many facilities need only modernization to become profitable once more. A large-scale, hot water, district heating system for the St. Paul metropolitan area has been shown to be feasible.[87] Heat would be supplied from converted turbines of existing power plants currently using coal, replacing normal space heating fuels such as natural gas and oil.

The second type of cogeneration system which is common in Europe and used to be in the United States, is the use of industrial steam to produce electricity. Nearly half of all energy used in industry produces steam capable of electrical generation. However, institutional barriers exist such as the problem of incorporating electricity by an industrial firm into the regulated utility system.[90]

Nuclear power composes 12 percent of the steam-electric generation in the region, but it faces an uncertain future. Unresolved radioactive waste disposal problems, reactor siting issues, construction costs, and safety regulation disputes have hampered construction as predicted by the Nuclear Regulatory Commission. These uncertainties have persuaded the Wisconsin Public Service Commission to declare a moratorium on nuclear plant construction.

Coal conversion (synthetic fuel production) is in its development stage in the region and could become a major energy producer. The two primary coal conversion processes are liquefaction and gasification. Coal liquefaction is a highly water consumptive process which yields liquid fuels similar to crude oil or refined petroleum products. Water is used for steam generation and to supply hydrogen for certain reactions, as well as quenching, sluicing, and pollution control. Average water use would be approximately 22 MGD for a plant producing 100,000 barrels per day. Coal gasification can yield either a high Btu sulfur-free fuel which can be directly substituted for natural gas or a low Btu gas which must be used near the production site. High sulfur coal from Illinois, Iowa, and Missouri could be gasified to provide fuel for combustion turbine electric plants. Water withdrawal for a high Btu gasification plant could range from 7.3 to 31 MGD for a plant producing 250 million cubic feet of 940 Btu/cubic foot gas. Water consumption is 10-15 percent of water withdrawal.[91]

A coal gasification demonstration plant for Wood River that will convert high-sulfur Illinois coal to low Btu gas was approved by the Illinois Energy Resources Commission early in 1979. The construction of similar facilities could accelerate coal mining in Illinois which has declined considerably over the last few years in favor of low-sulfur western coal.

Gasohol is probably the most widespread use of biomass for energy production. The industry will begin rapid development with the construction of the largest gasohol plant in the U.S.built in Sioux City, Iowa. The plant will market gasohol throughout the midwest, boosting the local industrial economy, regional agriculture, and regional energy outlook. Low-grade steam from coal-fired generating plants can support these facilities. Gasohol plants need large amounts of water for processing and cooling purposes. It takes 5-12 gallons of water to process one gallon of alchohol. About 100 gallons of water are required for cooling purposes but are recycled.[92]

Energy facilities such as steam-electric, gasohol,and coal conversion plants can be highly visible and require large sites, railroad access, and a large continuous water supply. Though special control of power plant siting is present

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[89]Minnesota Energy Agency, "District Heating and Cooperation as an Integral Part of Minnesota's Energy Policy and Conservation Plan," paper presented at Sixth Annual Illinois Energy Conference, Chicago, Ill., September 1978.

[90]Robert Stabauch and Daniel Yergin, "A Bright Energy Future with Saving and Sun," Foreign Affairs, Spring 1979.

[91]Illinois State Water Survey and Illinois State Geological Survey, Coal and Water Resources for Coal Conversion in Illinois, 1975.

[92]Personal Communication, Iowa Natural Resources Council, February 1981.

throughout the region, Illinois, Iowa, and Missouri lack statutory mandates to adequately evaluate the environmental suitability of proposed large-scale energy facilities.

Renewable energy resource facilities (hydropower, solar, and biomass) are usually smaller, less obtrusive, and more decentralized than steam-electric or coal conversion plants. The development of renewable energy resources could also help reduce water consumption in energy production. Hydropower is well developed in Wisconsin but there are opportunities for small-scale hydroelectric facilities throughout the region. Uses for solar energy can be found in urban and rural areas. Agricultural biomass sources provide the resources for gasohol production, and peat found in the northern portion of the region could be utilized as an energy source.

Hydroelectric power is not new to the region but it is becoming an increasingly attractive clean and renewable energy alternative to supplement nuclear and fossil fuels. Municipalities and the private sector recognize this and are beginning to investigate the power potential of existing dams in the region.

In 1975, 2.5 percent of the region's power was generated by hydroelectric facilities. Utilizing existing dams in the region, there is a potential to produce an additional 10,600 GWh of power via hydroelectric facilities by either rehabilitating existing hydro-plants, expanding existing hydro-plants, or installing hydro-facilities at existing dams (Table II-33). About 85 percent of this potential production could be derived from small dams with a generating capacity of 5,000 KW or less. Full development of this hydroelectric potential at existing dams is not likely but the generating potential could be significant. Full development could defer up to 20 percent of the projected power plant capacity and 8 percent of the projected generation needs of the region for the next ten years.[93]

Numerous municipalities on rivers or streams throughout the region have underdeveloped or unused small-scale hydroelectric facilities. Many hydroelectric facilities were abandoned in favor of cheap power from large-scale power plants. Nearly all were neglected and fell into disrepair and some turbines were sold as scrap metal. Rising energy costs though, have quickly renewed interest in this "rediscovered" energy source. State statutes have granted municipalities important powers to acquire and operate public utilities within their corporate limits which place them in an excellent position to redevelop small-scale hydroelectric power sites. The Federal Energy Regulatory Commission has recently streamlined its permit process for small-scale hydroelectric development.

Solar energy is receiving considerable attention because like hydropower, it is clean and renewable, but more accessible to a larger population. Solar systems have minimum effects on the environment and solar energy use could reduce the environmental effects of consuming conventional fossil fuels. Solar power is generally not developed throughout the region though industrial, domestic, and agricultural sectors could benefit. Large solar collectors could furnish as much as 15-20 percent of industrial heat requirements.[94] Home space heating and domestic hot water heating are other solar uses most likely to affect electrical demand. Agricultural crop drying which now consumes a significant amount of agricultural energy could be augmented with solar heated air. The heating of livestock shelters, rural

TABLE II-33. POTENTIAL HYDROELECTRIC PRODUCTION AT EXISTING DAMS, UPPER MISSISSIPPI REGION

	Additional Capacity (MW)	Additional Output (million KWh)
Large Dams (capacity greater than 5000 KW)		
Rehabilitation	52	270
Hydro-Expansion	80	261
Hydro-Installation	199	1077
Small Dams (capacity less than 5000 KW)	4378	8991

Source U.S. Army Corps of Engineers, Estimate of National Hydroelectric Power Potential at Existing Dams, July 1977.

[93] U.S. Army Corps of Engineers, Estimate of National Hydroelectric Power Potential at Existing Plants, July 1976.

[94] Minnesota State Planning Agency, The Governor's Report on Environmental Quality, 1979.

residences, and foodstuff processing could also utilize solar heat yielding a saving of petroleum to the mechanized farm sector.

Biomass material is abundant and could begin to influence regional energy production. Wood, crop residues, animal wastes, lowland crop cover, marsh reeds, dairy processing by-products (lactose, whey), and peat are all possible energy sources. Studies are not yet complete but suggest that biomass use would have less adverse effects on water resources than the mining and burning of fossil fuels.

The use of animal wastes to generate methane gas is attracting interest in the agricultural community as a substitute for natural gas. There are farms scattered throughout the region which are heating animal buildings with methane.

Peat bogs in the upper portion of the region are considered a fossil fuel and a viable regional supplement to established energy sources. Though peat is 90 percent water in its natural state, after drying it can be used directly as a fuel to generate power or converted into a substitute natural gas.

The burning of solid wastes to produce steam, hot water, or electricity is a commercially viable technology being utilized by increasing numbers of industries and municipalities. Rising energy costs and refuse disposal costs favor increased use of refuse in the future. The Bi-State Development Agency is planning a "waste to energy" project for the St. Louis region.

The increasing development of steam-electric generation and coal conversion plants in the region could accentuate associated water resource problems. Non-water consumptive energy alternatives such as solar, wind, biomass, and solid wastes with the exception of hydropower, are not individually significant energy industries. Nevertheless, no one energy alternative can be relied on to meet future energy needs. Rather, a combination of various regional and local energy resources should be developed to appropriately support and complement national energy trends and insure the integrity of the region's water resources.

Anticipated Problems

The population and economy of the region are projected to grow at a consistent rate, but urban areas will develop more rapidly. Related development will cause future electrical generation to nearly double by 2000. In addition to expected growth in urban areas, agricultural trends indicate an increasing need for more energy. About 45 percent of the energy used in agriculture is concentrated in seven states, three of which, Illinois, Iowa, and Minnesota, are in the region.[95]

Petroleum shortages should shape the energy industry as it expands to meet the increasing energy demands associated with growth and development. The increased use of coal will continue to encourage water consumptive coal technologies and accentuate stress on water supply in areas of concentrated energy production.

Coal fired steam-electric generation supplies most of the electricity in the region and is projected to increase capacity to meet energy needs through 2000. Additional steam-electric plants will have an increasing effect on water resources. Burning low-sulfur coal and e quipped with 95 percent efficient scrubbers, 25 medium sized steam-electric plants could release as much as 80 to 90 million pounds of sulfur dioxide per year into the atmosphere.[96] Sulfur dioxide combined with rain water in the atmosphere will create an acid rain which can reduce agricultural productivity, damage forests, and eliminate biological life in lakes. Already confirmed in the Northeast, acid rain effects are beginning to be observed in the Middle

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[95]U.S. Department of Agriculture, Structure Issues of American Agriculture, Agricultural Economic Report 438, 1979.

[96]Skip Laitner, "Iowa Power Plant Expansion," Des Moines Register, 9 November 1978, p. 16A.

West.[97]

Water use from additional steam-electric plants will reduce the amount of water available for domestic, industrial, and agricultural use. Cooling methods that represent "best available technology" specified by the Clean Water Act of 1977 are more water consumptive than once through cooling further increasing energy's share of water use in the future.

Coal conversion plants, also highly water consumptive, may become essential energy sources because of their non-polluting use of large available deposits of high-sulfur, high Btu Illinois, Missouri, and Iowa coal. Large quantities of water will be used for cooling and processing, altering the discharged water in physical state, mineral quality, and temperature. About 10 percent of the water could be consumed.[98]

Gasohol plants are expected to increase throughout much of the region which could lead to competition between other energy water users. About 30 plants are expected to be built in Iowa by 2000.

Energy facility siting will become more difficult as appropriate sites become less available. Coal conversion plants will compete with gasohol, and steam-electric plants for sites with suitable water supplies. Without clear and consistent siting policies in the region, interstate conflicts could result over water supply. Land use disruptions and environmental effects could become more severe.

A greater reliance on coal than oil will promote extensive mining in Illinois and some in Iowa and Missouri with perhaps deleterious results to water and air quality from the additional mining. Environmental standards may need to be re-evaluated to facilitate extensive use of coal. Addition coal combustion, however, could increase acid rain.

Though the future of nuclear power is yet unclear, problems inherent to nuclear reactors must be considered for existing and anticipated plants. Safety regulations and the disposal of radioactive wastes are serious issues that require resolution. Accidental radioactive emmissions from nuclear plants pose a direct hazard to water resources. Situated on large rivers or bodies of water these plants are often located upstream from major urban areas or share a common water source with other communities. The utilities that own or operate the plants do much of the monitoring of radioactive discharges, not the states or agencies responsible for making health and safety decisions in the event of an accident. Additional nuclear steam-electric plants will only increase the potential for nuclear accidents unless these issues are resolved.

Governmental Authority, Responsibility, and Policy

The consequences of energy facility siting and energy resource development are inherently local though energy development is based on regional resource constraints and satisfies regional demand. Energy facilities and resource development are regulated by federal and state agencies. Regulation of interstate utilities and hydroelectric licensing is a federal responsibility. States manage intrastate energy resources, facilities, and utilities.

In 1977, the fuel shortage prompted the federal government to consolidate major energy areas into one executive department. The Energy Organization Act established the Department of Energy (DOE) as a single authority incorporating duties of the Energy Research and Development Administration, the Federal Energy Administration, the Federal Power Commission, and many other federal energy agency functions. The DOE develops conservation goals and regulations as well as programs to improve energy efficiency and reduce consumption.

To supplement and diversify current energy industries, the Assistant Secretary for Energy Technology coordinates research, development, and technology in all energy areas. The Office of National Environmental Policy Act Affairs assures that energy does not receive priority over relevant environmental considera-

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[97] Al McConagha "EPA Study of Acid Rain Threat to Environment Gets Top Priority," Minneapolis Tribune, 8 October 1979, p. 2B.

[98] Illinois State Water Survey and Illinois State Geological Survey Coal and Water Resources for Coal Conversion in Illinois, 1975.

tions. The office requires agency-wide implementation and compliance with the National Environmental Policy Act.

Interstate electric power and natural gas industries are regulated by the Federal Energy Regulatory Commission (FERC), an independent agency within the DOE. The FERC sets rates for the transportation and sale of natural gas, the transmission and sale of electricity, and the transportation of oil by pipeline (Table II-34).

The FERC is also responsible for promoting and encouraging the efficient utilization of water resources, particularly hydroelectric power. In cooperation with other federal agencies, the FERC studies the potential for hydropower development and the market and value of potential power. The FERC also issues licenses to nonfederal public and private entities for hydroelectric projects.

As the development of energy sources has escalated, so has the environmental effects of energy resource development and energy facilities. The Environmental Protection Agency (EPA) enforces the Clean Water Act and its amendments which limit thermal pollution from power plant discharge. States are required to develop water quality standards for pollution control in accordance with the Water Quality Management Planning Regulations administered by the EPA.

The Department of the Interior also evaluates the effect of energy development on the environment. Mining pollution is investigated by the Bureau of Mines. The U.S. Fish and Wildlife Service investigates studies on new power plant and transmission line projects to determine the effects on the environment. Energy resources are evaluated by the U.S. Geological Survey.

Energy organization varies from state to state within the region. Generally states vary between a lead agency approach and a system approach involving multiple agencies. Until recently, energy has not been a critical issue. Consequently, state agencies have dealt with energy strictly within their jurisdiction, always strengthening their separate responsibilities.

The most common approach to organizing energy responsibilities is a multi-agency system centering around a public service commission or public utility commission which regulates investor-owned public utilities. Illinois, Indiana, Iowa, Missouri, and South Dakota have independent multi-interest agencies that support utility regulation by investigating the need for large scale energy facilities, conducting research and collecting data on energy supplies, formulating state energy policy, and investigating alternative energy resources. Minnesota combines all support activities into one energy agency which only excludes utility regulation and power plant siting authority. The Wisconsin Public Service Commission exemplifies the lead agency approach by regulating utilities, licensing energy facilities, and planning for energy resources and supplies.

Power plant siting is regulated to some degree in all states. The Illinois, Iowa, and Missouri rate regulating authorities can make decisions on engineering and economic grounds but not on environmental grounds alone. Indiana requires counties to authorize siting as part of zoning responsibilities and Wisconsin's Public Service Commission mandates a 10 year projection review process of a utilitity selected site. The Minnesota Environmental Quality Board requires an alternative site selection process to ensure best site selection by environmental criteria.

Alternative Solutions and Effects

Energy problems in the region are related to the future development of water consumptive energy facilities, especially steam-electric plants. Alternative solutions which address these problems are based on projections of increased energy use and reliance on steam-electric generation to meet electrical demand (Table II-35). The following problems are most important in the region:

(1) Increased electrical demand. Increased agricultural needs for energy and urban growth and development could cause electrical generation to nearly double by 2000.

(2) Expansion of water consumptive energy facilities. Steam-electric plants produce most of

TABLE II-34. GOVERNMENTAL AUTHORITY AND RESPONSIBILITY FOR ENERGY, UPPER MISSISSIPPI REGION

Agency		Authority[a]	Primary Program (function)
		U.S. GOVERNMENT	
DEPARTMENT OF AGRICULTURE Rural Electrification Administration	R,I	Rural Electrification Act of 1968 (as amended)	(finances electric facilities in rural U.S.)
DEPARTMENT OF ENERGY	S,R,I	Department of Energy Organization Act of 1977 (P.L. 9S-91)	Conservation (reduces growth of energy demand)
			Research, Development, and Applications (facilitates technology development to expand future energy supply)
			Direct Energy Production (responsible for production and sale of uranium for nuclear plants; development, production, and sale of oil from navel petroleum reserves; and distribution and sale of electric power in marketing areas)
Economic Regulatory Administration	R	Department of Energy Organization Act of 1977 (P.L. 9S-91)	(diminishes use of oil and natural gas by utilities and industry by promoting conservation and efficiency)
	R,I	National Energy Conservation Policy Act (P.L. 9S-619)	(establishes procedures and guidelines for the development, implementation, and federal assistance of state conservation programs)
OEPARTMENT OF TRANSPORTATION Materials Transportation Bureau	R,E	Natural Gas Pipeline Safety Act of 1968 (P.L. 9D-481)	(develops and maintains state gas pipeline safety programs)
ENVIRONMENTAL PROTECTION AGENCY	R,E	Clean Water Act, section 316 (P.L. 9S-217 as amended)	(requires use of "best available technology" for power plant cooling systems and requires intakes to minimize adverse effects--aquatic organisms)
	S	Clean Water Act (P.L. 9S-217 as amended)	(supports research to determine and control the environmental effects associated with energy)
	S	Resource Conservation and Recovery Act of 1976 (P.L. 94-S80)	(development of management plans and facilities for resources recovery and management of hazardous wastes)
FEDERAL ENERGY REGULATORY COMMISSION	R,E	Department of Energy Organization Act of 1977 (P.L. 9S-91)	(regulates interstate aspects of electric power and natural gas industries)
	R	Public Utility Regulatory Policies Act (P.L. 95-617)	(sets guidelines for the regulation of public utilities)
NUCLEAR REGULATORY COMMISSION	R,E,I	Energy Reorganization Act of 1974 (P.L. 93-438)	(monitors and regulates the safe use of nuclear energy for the generation of electricity)
	S	Atomic Energy Act (as amended)	(assists states in achieving, maintaining, and improving capabilities to conduct radiation control programs)
		ILLINOIS	
COMMERCE COMMISSION	R	IL Statutes, Chapter 111 2/3, Sections 1-7, Public Utilities Act, Electric Supplier Act, Illinois Gas Pipeline Safety Act	(regulates utilities)
DEPARTMENT OF NUCLEAR SAFETY	R	IL Statutes	(regulates nuclear waste storage sites)
DEPARTMENT DF TRANSPORTATION Division of Water Resources	I	IL Statutes, Chapter 19, Section 41.1 S2-106, 119-126h, and 1071-1D77.13 and IL Statutes, Chapter 127, Sections 49-49.2S	(transport of energy resources and products)
INSTITUTE OF NATURAL RESDURCES	S	IL Statutes, Chapter 127, Section 62	(alternative energy, fuel management, and coal development)
		INOIANA	
OEPARTMENT OF COMMERCE	S	IND Code 4-4-3-18	(monitor energy production, consumption; alternative resources development)
PUBLIC SERVICE COMMISSION	R,E	INO Code 8-1-2	(regulates utilities)
		IOWA	
DEPARTMENT DF ENVIRONMENTAL QUALITY	R	IA Statutes, Chapter 4SS8	(controls and abates air and water pollution)
DEPARTMENT OF SOIL CONSERVATION	R	IA Statutes, Chapter 83A and IA Statutes, Chapter 467A	(environmental standards for surface mining)
ENERGY POLICY COUNCIL	S	IA Statutes, Chapter 93	(state energy policy)
EXECUTIVE COUNCIL	R	IA Statutes, Chapter 19 and IA Statutes, Chapter 409A	(regulates hydroelectric plants)
IOWA COMMERCE COMMISSION	R	IA Statutes, Chapter 474 and IA Statutes, Chapter 476A	(regulates pipelines, transmission lines, and power plant construction)
IOWA NATURAL RESOURCES COUNCIL	R	IA Statutes, Chapter 4SSA	(water use permit system)

TABLE II-34. (Continued)

Agency		Authority[a]	Primary Program (function)
		MINNESOTA	
ENERGY AGENCY	R	MN Statutes, Chapter 116H	(state energy policy, research, certifies need for large-scale energy projects)
ENVIRONMENTAL QUALITY BOARD	R	MN Statutes, Chapters 116C, 116O, and 116G	(approves new power plant sites and transmission line right-of-way)
POLLUTION CONTROL AGENCY	E	MN Statutes, Chapters 115, 116, and 116A	(limits energy facility effluents discharged into lakes and waterways)
PUBLIC SERVICE DEPARTMENT	R	MN Statutes, Chapters 216, 216A, and 216B	(regulates utilities)
STATE PLANNING AGENCY	S,R	MN Statutes, Chapters 4, 116C, and 116G	(staffs Environmental Quality Board for power plant siting)
		MISSOURI	
DEPARTMENT OF CONSUMER AFFAIRS, REGULATIONS AND LICENSING	S	Senate Bill No. 1, Section 4, 1974	(investigates need for energy facilities)
DEPARTMENT OF NATURAL RESOURCES	S,R	Senate Bill No. 1, Section 4, 1974	(data on energy supplies, consumption, prices; conservation and energy information)
PUBLIC SERVICE COMMISSION	R	Chapter 393	(utility rates, approves power plant construction)
		SOUTH DAKOTA	
DEPARTMENT OF WATER AND NATURAL RESOURCES Water Management Board	R	Compiled Law, 48-5, 46-6	(grants permits for use of surface and groundwater for energy facilities)
ENERGY POLICY OFFICE	S	Executive Order 74-5	(state energy policy, alternative renewable energy resources, conservation)
PUBLIC UTILITY COMMISSION	R	SO Compiled Law, Chapter 49	(regulates utility rates)
		WISCONSIN	
DEPARTMENT OF ADMINISTRATION	S	WI Statutes, Chapter 16	(long-range planning to promote development and maximum use of energy)
DEPARTMENT OF DEVELOPMENT	S	WI Statutes, Chapter 60	(coordinates planning efforts for state economic and energy resources)
DEPARTMENT OF NATURAL RESOURCES	R	WI Statutes, Chapter 196	(regulates air and water emissions, exemptions for once-through cooling. Cooperates with PSC on power plant siting and location of powerlines)
PUBLIC SERVICE COMMISSION	R,E	WI Statutes, Chapter 15	(regulates utilities, licenses energy facilities, and enforces regulations pertaining to public utilities)

[a]Scope of authority is defined as follows:
S= Statutory: research, collect information, coordinate, prepare plans
R= Regulatory: establish rules and regulations, issue permits
E= Enforcement: enforce laws and regulations
I= Implementation/Construction: administer funds, acquire land, construct and operate projects

Sources: "Department of Nuclear Safety for Illinois," Springfield Journal Register, 2 April 1980, Sec. 2, p. 13.
Executive Office of the President, Office of Management and Budget, 1979 Catalog of Federal Domestic Assistance, May 1979.
U.S. Department of the Army, Office of the Chief of Engineers, Digest of Water Resources Policies and Authorities, September 28, 1979.
Upper Mississippi River Basin Commission, FY 1978 Program Report of State and Federal Water and Related Land Resources Efforts, December 1978.
Upper Mississippi River Basin Commission, Upper Mississippi River Main Stem Level B Study, Technical Paper G: Legal and Institutional, August 1979. (draft)

the electricity in the region and continued development could affect water resources. The availability of resources for gasohol and cool conversion plants could lead to their expanded development and competition with other offstream water users.

Serious conservation efforts can benefit the entire range of energy issues and should be considered as important as the development of new energy sources. Energy conservation is the most accessible and convenient alternative for reducing both energy consumption and the economic, social, and environmental costs of expanded energy production. Industry is the largest consumer of energy--nearly 40 percent of the nation's fuel. The residential and transportation sectors each use about 20 percent.[99] Stricter conservation controls for these sectors could prevent costly programs to promote energy production or harsh measures to reduce consumption.

Steam-electric generation will continue to produce most of the electricity in the region but an emphasis on planning and constructing smaller plants of 200-400 MW could result in less water consumption. Smaller plants can be located closer to the populations they serve and power losses which occur during transmission of electricity over long distances could be reduced. Plants can be matched more closely to cogeneration and district heating opportunities usually found in urban areas.[100]

Energy facilities are not densely situated and have not significantly affected water resources, but future concentrations of energy facilities could adversely affect the quantity and quality of water resources. Interstate cooperation or an interstate authority could facilitate the formulation of energy supply and demand projections, the size and type of energy facilities, the review of acceptable sites, and the analysis of interstate effects of energy development in the region.[101] Land use and environmental effects could be reduced.

States and utilities have predominant responsibility for siting and routing energy facilities, however, regional cooperation and coordination could benefit both producers, consumers, and regulators of energy. State by state licensing precludes coordinating siting at the regional level, resulting in less-than-best sites for energy facilities. Strict regulation of water consumptive energy facilities on environmental as well as engineering grounds could alleviate future water resource conflicts.

The amounts of water consumed by steam-electric plants to disperse waste heat can be reduced in some cases using once-through cooling which consumes less water than closed-cycle systems such as cooling ponds or wet towers. Implementation of closed-cycle cooling is projected to quintuple water consumption by 2000 while electrical generation only triples.[102] The Clean Water Act of 1977 discourages once-through cooling by requiring "best available technology" to dissipate waste heat. Applicants can appeal but must prove that "best available technology" is unnecessary to insure environmental criteria including impingment effects. New power plants could be granted technical assistance from state and federal licensing agencies to determine if once-through cooling can meet the requirements of the Clean Water Act which are to "assure the protection and propagation of a balanced, indigenous population of shellfish, fish, and wildlife in and on that body of water."

The additional combustion of coal from scheduled steam-electric plants could increase the risk for acid rain in the Middle West. An evaluation of coal combustion and the potential for acid

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[99]Richard Korrigan, William Lanonette, and Robert J. Samuelson, "The Energy People and Government--Playing New Roles," National Journal 23 (June 1978), pp. 912-925.

[100]Minnesota Environmental Quality Board, Options for Electric Energy Supply, 1980.

[101]National Governors' Association, State Perspectives on Energy Facility Siting, by David W. Stevens, 1978.

[102]Ohio River Basin Commission The Ohio Main Stem: Water and Related Land Resources Study Report and Environmental Impact Statement, 1978.

TABLE II-35. ALTERNATIVE SOLUTIONS TO ENERGY PROBLEMS AND NEEDS: ANALYSIS AND EVALUATION[a], UPPER MISSISSIPPI REGION

Alternative Solution (Problem Addressed)	Four Account Effects				Evaluation			Conclusion
	NEO	EQ	REO	OSE	Planning Objective	Effi-ciency	Accept-ability	
(1) Promote district heating and industrial uses of waste heat for existing and scheduled steam-electric plants by identifying opportunities for utilizing waste heat, conducting feasibility studies, and providing economic assistance (Expansion of water consumptive energy facilities)	- national costs + non-agricultural output + energy	+ fish & wildlife habitat + instream flows	+ economic stability + water supply - state costs	+ emergency preparation	NEO,EQ	High	High	Recommended
(2) Evaluate the potential for acid rain from coal combustion by scheduled steam-electric plants to determine the need for stricter,air quality standards (Expansion of water consumptive energy facilities)	- national costs	+ fish & wildlife habitat + surface water quality	- state costs	+ health & safety + aesthetics	EQ	High	Medium	Recommended
(3) Permit the use of once-through cooling facilities for steam-electric plants where water quality and instream flow can assimilate waste heat (Expansion of water consumptive energy facilities)	- national costs + non-agricultural output	+ instream flows	+ water supply	- aesthetics	NED	High	Medium	Conditionally Recommended
(4) Oevelop power production at smaller (200-400 MW) steam-electric plants as an alternative to large-scale power plants. The states and utilities should utilize small-scale plants to reduce effects on water resources, produce power closer to the populations served, and increase opportunities for utilizing cogeneration and district heating (Increased electrical demand; Expansion of water consumptive energy facilities)	- national costs + non-agricultural output + energy	+ instream flows	+ economic stability + jobs - state costs - private costs	+ emergency preparation + aesthetics + real income	NED	High	High	Recommended
(5) Require water consumptive energy facilities (steam-electric, gasohol, and coal conversion plants) to be sited where water supply is adequate to minimize conflicts between competing uses and other water resource needs (Expansion of water consumptive energy facilities)	- national costs	+ fish & wildlife habitat + surface water quality + instream flows	+ water supply - state costs	+ health & safety + aesthetics	NEO,NS	High	Medium	Recommended
(6) Increase incentives for implementing energy conservation measures by increasing tax credits, penalties, and technical assistance to encourage more efficient building codes, thermostat regulations, and other conservation measures (Increased electrical demand; (Expansion of water consumptive energy facilities)	- national costs + non-agricultural output + energy	+ fish & wildlife habitat + surface water quality + instream flows	- state costs + water supply	+ real income + education + emergency preparation + aesthetics	NED,EQ, NS	High	High	Recommended
(7) Oevelop alternative energy sources (hydroelectric, solar, and biomass) through increased tax credits, low interest loans, direct subsidy, building codes, and technical assistance (Increased electrical demand; Expansion of water consumptive energy facilities)	- national costs + non-agricultural output + energy	+ fish & wildlife habitat - instream flows	+ jobs + economic stability + flood damage reduction	+ real income + emergency preparation + aesthetics	NED,EQ	High	High	Recommended
(8) Inventory and evaluate hydroelectric power potential in the Upper Mississippi Region, identify acceptable hydroelectric power objectives and implement projects to meet those objectives at existing sites (Increased electrical demand)	- national costs - non-agricultural output + energy	+ fish & wildlife habitat	+ jobs + economic stability - state costs	+ emergency preparation	NED,EQ	High	High	Recommended
(9) Promote industrial generation of electricity, especially in urban areas by identifying industries with electrical potential and facilitating cooperation between industry and utilities (Increased electrical demand; Expansion of water consumptive energy facilities)	- national costs + energy + non-agricultural output	+ fish & wildlife habitat + surface water quality + instream flows	- state costs + water supply	+ real income + emergency preparation - aesthetics	NED,EQ	High	Medium	Recommended
(10) No action	+ federal cost - non-agriculture output + energy output	- fish & wildlife habitat - surface water quality - instream flows	- jobs - economic stability - water supply + state cost	- real income - health & safety - recreation - emergency preparation - aesthetics		Low	Low	Not Recommended

[a]Abbreviations in the Table: NEO (National Economic Oevelopment), EQ (Environmental Quality), REO (Regional Economic Oevelopment), OSE (Other Social Effects), NS (Nonstructural), XX (Not applicable)

For complete definition of Effects, Planning Objectives, Efficiency, Acceptablility, and Conclusions see Appendix E.

rain could determine the need for stricter air quality standards.

The use of cogeneration both in power plants and industry can reduce projected energy demand by efficiently using waste heat from these facilities. Power plants can cogenerate electricity and utilize waste heat for nearby district heating or industrial uses. Some industry is capable of cogenerating process heat for manufacturing and utilizing the waste heat for electrical generation. Cogeneration has been used in the past and many abandoned facilities could be retrofitted or rehabilitated to contribute to the region's energy needs. Cogeneration for power plants and industry can be encouraged in the design of new facilities. The siting process could consider the best use of cogeneration capability for nearby or potential users. Utility regulations could promote electrical generation by industry.

Renewable energy sources supplement energy production in the region. Their increased development could reduce the projected demand for steam-electric plants and coal conversion technology. Hydroelectric generation, solar energy, and biomass conversion have the greatest potential for renewable energy production. High initial costs can discourage developers unless strong incentives are available. Renewable energy sources can be encouraged through tax credits, low interest loans, and direct subsidy. Technical assistance could be incorporated into the DOE Appropriate Technology Program, the primary funding program for non-solar projects.

Hydroelectric potential exists at undeveloped dam sites, dams without hydroelectric facilities, and abandoned hydroelectric facilities. Abandoned facilities could be rehabilitated especially those owned by municipalities. Municipalities have the authority to acquire and operate utilities and can finance a facility. Installation of hydropower facilities at existing dams may be more costly but could further increase electric generation in the region. Excessive costs may preclude construction of hydropower facilities of undeveloped sites.

The development of small-scale hydroelectric facilities (15 MW or less) at existing dams is most feasible, but economic incentives are needed to encourage projects. Improved rate structure could encourage the sale of hydroelectric power to utilities.

Solar heating, though usually small in scale, could yield a significant amount of petroleum savings if highly promoted in the industrial, residential, and agricultural sectors. Biomass applications are concentrated in the rapidly growing gasohol industry which could reduce the need for coal liquefaction facilities.

Nuclear power could be more closely regulated to alleviate possible environmental effects. Responsibility for nuclear power is shared by private, state, and federal entities without clear or consistent guidelines. Strict regulations for the disposal of wastes generated by nuclear plants and for radioactive water quality emission monitoring may be necessary if nuclear power is to continue to contribute to the region's energy production.

Conclusion

Without the implementation of any alternative in energy planning (no action), Upper Mississippi Region will continue to rely on large-scale steam-electric generation to meet increasing energy consumption. Environmental effects, especially low instream flows, will increase as steam-electric plants, gasohol plants, and coal conversion facilities are built and result in competition among off stream water users. No new programs will be initiated to encourage renewable energy development or conservation of energy. Projections for steam-electric generation will not be reduced and there will be no plans to reduce the effects of coal conversion facilities and gasohol plants on water resources.

Alternative solutions are consistent with energy and water resources objectives and can only be recommended as an integrated set of solutions. Individual alternatives cannot be expected to solve the problems of increased electrical demand or environmental effects.

Conservation measures can reduce electrical demand, but alternative sources of energy, especially hydroelectric, should be developed to supplement steam-electric generation. Both alternatives will require increased incentives to accelerate their implementation.

The development of smaller steam-electric plants to utilize groundwater sources could further reduce effects of additional energy facilities on water resources. Energy facility planning and siting should increase consideration of water use by energy plants and broaden attempts to mitigate these effects.

INSTREAM FLOWS

Current Conditions and Problems

Offstream water use has generally not severely reduced instream flows, but large demands and changes in legislation that encourage greater water consumption could result in conflicts with instream flow needs. Instream flows are necessary to protect water quality, navigation, recreation, fish, and wildlife. Instream and offstream needs for water have been in fundamental conflict in the western states for a long time. Historically, offstream uses have had a higher water allocation priority than maintenance of instream flows because water allocation doctrines have been oriented to economic interests rather than to environmental and recreational interests. Since the Upper Mississippi Region has not had extensive surface water use and instream resource needs are recognized, the region has an opportunity to stress instream resources in future water planning and legislation.

Streams supply a large share of the offstream water needs in the southern part of the region because groundwater availability and quality are inferior. But, since surface water use for municipal, industrial, and agricultural purposes does not approach the volumes in the western states, a strict apportionment of flows has not been necessary. Most municipalities and industries that rely on stream water are fortunately on streams that generally have suitable flow characteristics. Competition for surface water by offstream users has been minimal throughout the region but could increase, particularly in the south, as demands arise.

Steam-electric plants generate waste heat that requires a withdrawal of substantial amounts of surface water for cooling purposes. Once-through cooling diverts water from a surface source and returns the water directly to the source. Little water is consumed in this process, but the heated water can have an adverse effect on the environment and is considered a pollutant under the Clean Water Act. Where effluent limitations restrict heated-water discharges, closed-cycle cooling with wet cooling towers or with cooling ponds is used because water is recycled instead of returned to the source. Closed-cycle cooling is not extensively used in the region so withdrawals for energy remain large and consumption small. Shifts to closed-cycle cooling could have significant effects on flows of some streams. The trade-offs between flow maintenance and thermal pollution must often be considered on a case-by-case basis to assure maximum benefits for the aquatic ecosystem.

Instream flows are a factor in water quality programs involving planning, discharge permits, and construction of sewage treatment systems. Through the planning process, agencies identify effluent limitations necessary to ensure compliance with water quality standards. Dischargers are then issued permits which limit the amount of pollutants discharged, and construction of private and public wastewater treatment systems are based on these permit limits. When setting effluent limitations, instream flows are taken into account, but there is no guarantee that in five years flows will be adequate. If flows have diminished, additional treatment may be necessary.

Navigation requires sufficient flows in interior streams. These flows have been maintained for commercial traffic along navigable waterways in the Upper Mississippi Region through a series of locks and dams. Dredging is necessary at some locations where sediment volume is too large for the flow velocity to keep it in suspension. A more obvious flow concern is for recreational navigation. Small recreation crafts can use more streams than commercial crafts and some streams have seasonal low flows that limit recreation use. Each water recreational activity, including boating, canoeing, tubing, water skiing, swimming, and wading, has an optimal flow condition at a particular site that might conflict with other activities. Since few streams in the region are completely regulated, the preferred activity might change as seasonal flow patterns shift. While flow requirements for water quality, navigation, and sometimes recreation are definable, instream flow needs for fish and wildlife are more difficult to determine.

Extreme low flows can imperil aquatic life, so maintenance of some minimum flow

is desired. Recent methodologies attempt to define instream flow needs for the preservation of aquatic habitat and related environmental resources. One flow methodology, the "Montana Method," is based upon percentages of the average flow but is primarily valuable for recommending instream flows in the early planning stages.[103] Different flow regimes change the aquatic habitat, thus influencing the fish and wildlife population. Ten percent of the average flow is the "limited survival" instream flow "recommended to sustain short-term aquatic life forms."[104] If this flow condition persists, fish will migrate to a more suitable habitat and concentrate in the deeper pools and runs. Fishing will often improve in these crowded areas but overharvesting may result.

In the Upper Mississippi Region, the streams in the west and south exceed the "limited survival" flow less frequently and have inferior habitat for fish production than in the east and north (Figure II-26). This failure to exceed the "limited survival" flow is generally attributable to natural conditions rather than large offstream water use. Problems are accentuated in areas where water withdrawals compete with instream needs and these areas are usually near municipalities. Drainage has also increased runoff to such an extent that a large disparity between peak and low flows is evident. Impoundments have in some cases reduced disparities by regulating flows with reservoir discharges.

Other critical percentages in the "Montana Method" are the thirty percent of the average flow, which is the "base flow recommended to sustain good survival habitat for most aquatic species," and the sixty percent of the average flow, which is the "base flow recommended to provide excellent to outstanding habitat for most aquatic species during their primary periods of growth and for the majority of recreational uses."[105] Streams with the best flow patterns for maintaining a "good" flow are again in the north and east (Figure II-27). Only the streams with large flow discharges can consistently surpass the "good" flow.

Some points that should be considered, however, when applying the "Montana Method" are:

(1) the method is most applicable in the early planning stages,
(2) the instream flow regimens provide an indication of the relationship of flows to aquatic habitat,
(3) a "limited survival" flow may act perhaps as a minimum below which flows should not regularly drop,
(4) a constant flow is not recommended because vacillating flows are essential to maintain diverse aquatic habitat for various organisms and their life cycles, and
(5) no recommendations for vacillating flows are possible with this methodology.

Other methodologies attempt to define instream flow needs, but the one most currently used is the incremental method developed by the Cooperative Instream Flow Service Group (IFG) of the U.S. Fish and Wildlife Service.

The IFG incremental method allows quantification of the amount of potential physical habitat available for fish species and life history phases in a given stream segment, at various instream flow regimes with different channel configurations and slopes. A major advantage of the incremental methodology is that the minimum flow concept which is usually employed in recommendations is expanded so that the effect of vacillating flows on fish populations can be considered. Therefore, as decision-makers develop objectives for fishery management, the methodology can define those objectives in terms of instream flow requirements.

Wildlife instream flow needs may differ from needs for fisheries because the riparian vegetation may change with water fluctuation. Wildlife habitat can be substantially altered with changes to

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[103]Donald 1. Tennant, "Instream Flow Regimes for Fish, Wildlife, Recreation and Related Environmental Resources," in Symposium Proceedings: Instream Flow Needs, American Fisheries Society, Volume II (September 1976).

[104]Donald L. Tennant, op. cit. footnote 81.

[105]Donald L. Tennant, op. cit. footnote 81.

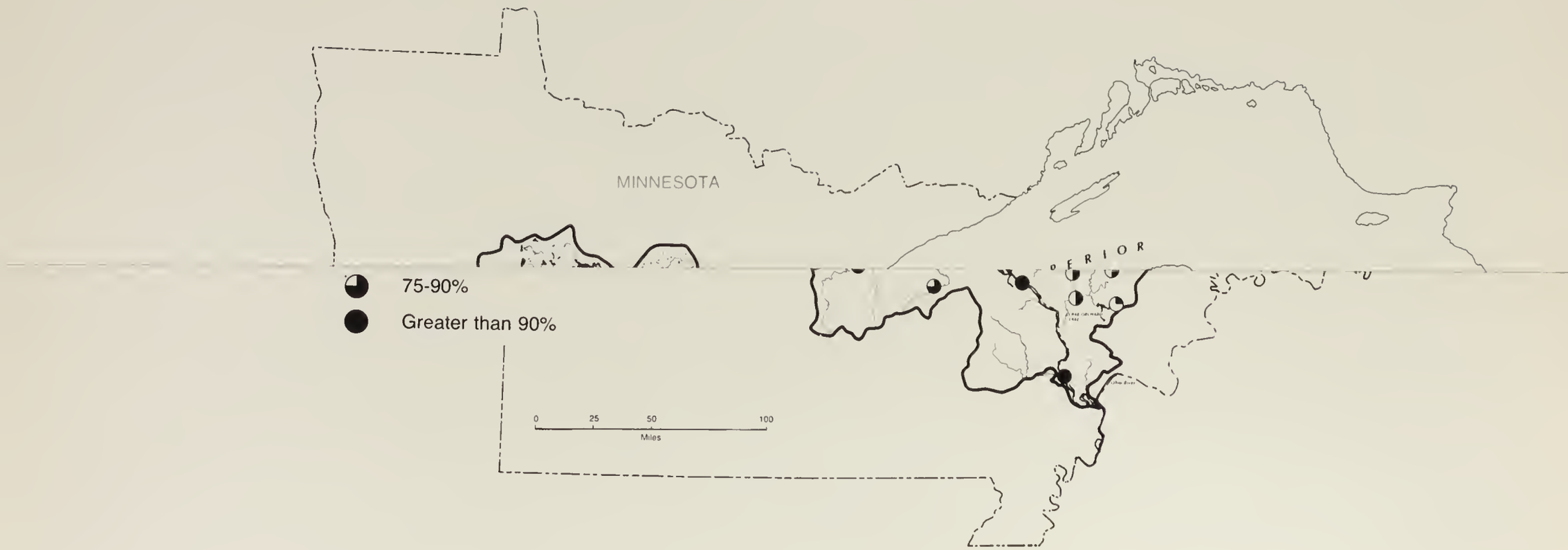

FIGURE II-26. "LIMITED SURVIVAL"* INSTREAM FLOW, UPPER MISSISSIPPI REGION

*"Limited Survival" is 10% of average flow

Sources: U.S. Geological Survey, *Water Data for Illinois, Water Year 1976; Water Data for Indiana, Water Year 1976; Water Data for Iowa, Water Year 1976; Water Data for Minnesota, Water Year 1976; Water Data for Missouri, Water Year 1976; Water Data for Wisconsin, Water Year 1976.*
U.S. Geological Survey, unpublished instream-flow data through 1976.

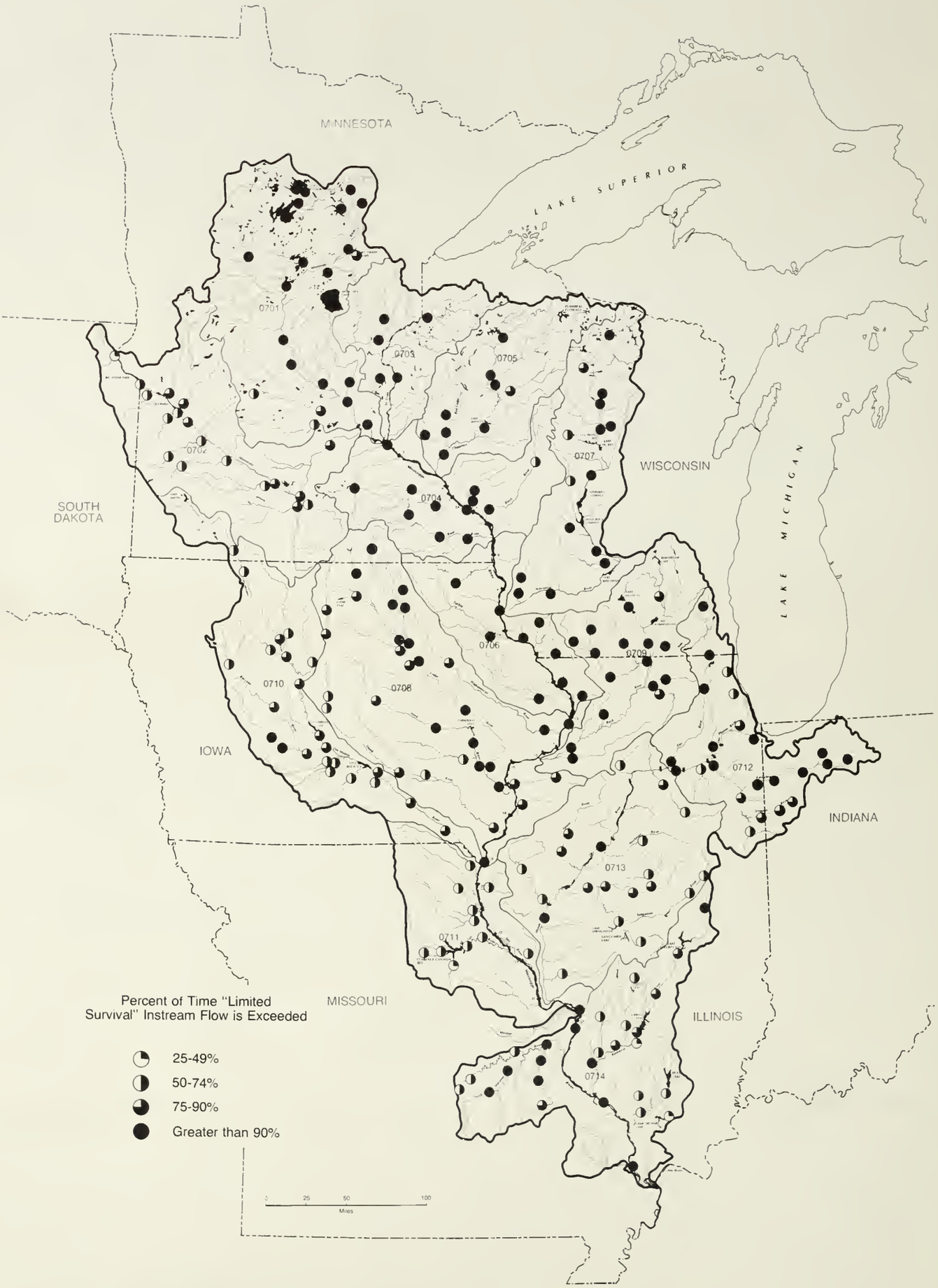

FIGURE II-26. "LIMITED SURVIVAL"* INSTREAM FLOW, UPPER MISSISSIPPI REGION

*"Limited Survival" is 10% of average flow

Sources: U.S. Geological Survey, *Water Data for Illinois, Water Year 1976; Water Data for Indiana, Water Year 1976; Water Data for Iowa, Water Year 1976; Water Data for Minnesota, Water Year 1976; Water Data for Missouri, Water Year 1976; Water Data for Wisconsin, Water Year 1976.*
U.S. Geological Survey, unpublished instream-flow data through 1976.

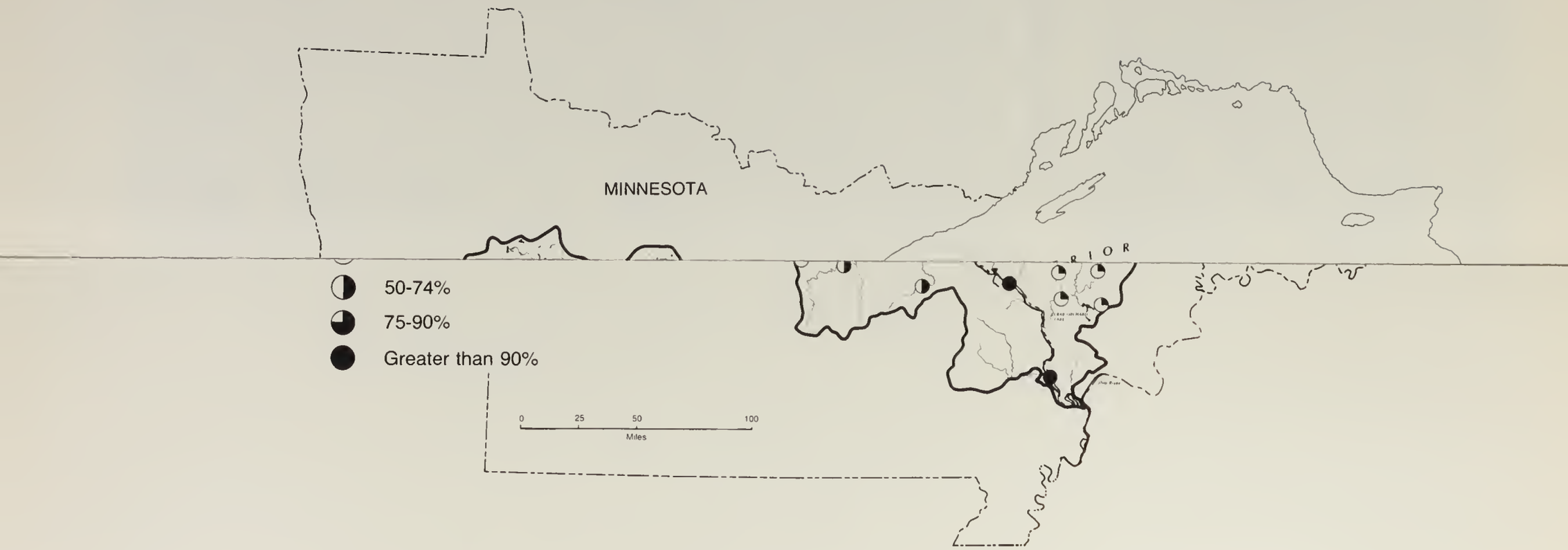

FIGURE II-27. "GOOD"* INSTREAM FLOW, UPPER MISSISSIPPI REGION

*"Good" is 30 percent of average flow

Sources: U.S. Geological Survey, *Water Data for Illinois, Water Year 1976; Water Data for Indiana, Water Year 1976; Water Data for Iowa, Water Year 1976; Water Data for Minnesota, Water Year 1976; Water Data for Missouri, Water Year 1976; Water Data for Wisconsin, Water Year 1976.*
U.S. Geological Survey, unpublished instream-flow data through 1976.

FIGURE II-27. "GOOD"* INSTREAM FLOW, UPPER MISSISSIPPI REGION

*"Good" is 30 percent of average flow

Sources: U.S. Geological Survey, *Water Data for Illinois, Water Year 1976; Water Data for Indiana, Water Year 1976; Water Data for Iowa, Water Year 1976; Water Data for Minnesota, Water Year 1976; Water Data for Missouri, Water Year 1976; Water Data for Wisconsin, Water Year 1976.*
U.S. Geological Survey, unpublished instream-flow data through 1976.

vegetation composition and structure, streambank slope, soil moisture, and depth to water table.

Instream flow management will become more important throughout the region particularly for streams with high quality fisheries and environmental features. Greater consumptive water use and rapid surface water drainage often conflict with environmental objectives. As research advances instream flow knowledge, decisions on problems and needs may dictate new legislation to achieve instream flow objectives. Some methods for reserving instream flow for fish and wildlife are available under existing laws, but strategies for reserving instream flows must be developed further.

Anticipated Problems

Offstream water demands influence flows of a stream when water is diverted from the stream or pumped from adjacent unconsolidated aquifers. Offstream consumptive water use will increase for all uses in the region but particularly for energy and industry which are the major surface water users. Implementation of closed-cycle cooling technology will prevent wastewater discharges but the flows of some streams will decline as water is no longer returned to streams. Dry-cooling towers would alleviate both the flow maintenance and thermal pollution concerns. However, a specific site analysis of available water supplies, flow characteristics, and the aquatic ecosystem would help determine the most practical technology.

The southern and western portions of the region will likely have most offstream use and instream need conflicts because surface water diversion is common and flows are naturally low during late summer and fall. Numerous impoundments do regulate flows as a functional purpose. As water demands exceed the water capabilities of these impoundments, conflicts may arise over further impoundment construction and enlargement, and the specific priority of instream flow in relation to other water needs. Unless consumptive water withdrawal is regulated and a priority use system established, fish and wildlife habitat degradation and offstream water shortages are probable. Water withdrawal from nearby unconsolidated aquifers should be also regulated because groundwater withdrawal can affect flows. Irrigation particularly influences flows because peak crop water requirements often coincide with low flows.

Governmental Authority, Responsibility, and Policy

Recognition and protection of instream flows are an increasing concern in both federal and state planning. Programs have been adopted that recognize instream flow values and allow them to be evaluated along with other factors in water resources programs and projects. Most early water development projects focused on navigation, flood control, hydropower, and other economic purposes. Public awareness of the environmental amenities often associated with these projects has resulted in the incorporation of such environmental factors as recreation, fishing, and water quality into national project planning.

Federal legislation now requires water resources development agencies to consider environmental quality and instream needs in the planning and implementation of projects. The National Environmental Policy Act of 1969 and the Principles and Standards for Planning Water and Related Land Resources have added new criteria for project approval and encourage a thorough display of alternative uses of water and related resources. These alternatives list the tradeoffs involved in the plan selection process. Maintenance of instream flows often requires some tradeoff with other important water uses. Other acts such as the Clean Water Act, Federal Land Policy and Management Act of 1976, Wild and Scenic Rivers Act, Endangered Species Act of 1973, and the Fish and Wildlife Coordination Act include provisions for protecting and maintaining instream flows.[106] Besides federal legislation, the President's Environmental Quality and Water Resources directive of July 12, 1978, acknowledges further emphasis on

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[106] Water Policy Implementation Interagency Task Force-Instream Flows, "Federal Legislation for the Protection and Maintenance of Instream Flows," May 1979.

federal action in instream flow management.

> In cooperation with the States, Federal agencies shall improve, where possible, the operation and management of existing water-resources projects to protect instream uses. While not interfering with State laws and responsibilities, Federal agencies shall set a strong example in recognizing and protecting legitimate instream flow needs.[107]

Federal agencies primarily involved with projects and programs in the Upper Mississippi Region and which must comply with new policy directives are the Army Corps of Engineers, U.S. Fish and Wildlife Service, U.S. Forest Service, National Park Service, and Environmental Protection Agency (Table II-36). Water development projects of the Army Corps of Engineers have occasionally neglected to consider the effects of reduced flows on fish and wildlife habitat. But because flows throughout the region have not been severely restricted by their projects, only one flow problem, caused by small releases from multipurpose reservoirs on the Kaskaskia River System, has been identified in a state survey.[108]

Other agencies are responsible for establishing regulations that define procedures for compliance with acts on flow requirements for fish, wildlife, recreation, and water quality. The Department of the Interior has primary responsibility for fish, wildlife, and recreation needs, and the Environmental Protection Agency for water quality needs. Programs of the Clean Water Act that affect instream flows are the water quality standards program, the water quality management program, the permit program for discharges of dredged and fill material, and those programs requiring consumptive waste treatment.[109] Section 102(b) of the Clean Water Act requires consideration of storage for regulation of streamflow in planning of reservoirs by federal agencies. State water law and water rights may conflict with pollution control requirements when discharge limitations are based on flows which change with state allocation systems.

Instream flow data collection and processing are necessary to determine allocations for offstream and instream needs. The U.S. Geological Survey operates a stream gaging network in cooperation with the states. The Cooperative Instream Flow Service Group of the U.S. Fish and Wildlife Service has done extensive research on methodologies for determining flow needs for fish and recreation and can assist states and federal agencies in establishing flow guidelines.

While the federal government has the general responsibilities to minimize the effects of federal actions on instream flow problems and to cooperate with states in developing programs to solve these problems, the states have the principal responsibility for protection of instream flows. State laws and regulations for the management of instream flow generally are not well established throughout the region. State water planning programs can provide a means for management because they often reach regulatory status through the existing authority of the agency creating the plan. If planning programs evaluate all potential demands on the state's water resources and make recommendations for the protection of instream values, state laws and regulations will follow.

In Illinois, no state laws and regulations explicitly protect instream flows but planning programs have begun which will determine instream flow needs for state streams. Most management and financing of instream flow planning is the responsibility of the Division of Water Resources of the Department of Transportation.

Indiana also has no laws or regulations that protect explicitly flows for

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[107]President Carter, "Memorandum to Implement Water Policy," July 12, 1978.

[108]Water Policy Implementation Interagency Task Force--Instream Flows, "Identification of Existing Federal Water Resources Development Projects where Instream Flow Uses could be Improved," May 1979.

[109]Environmental Protection Agency, Water Planning Division, Water Quality/Water Allocation Coordination Study, August 1979. (draft)

TABLE II-36. GOVERNMENTAL AUTHORITY AND RESPONSIBILITY FOR INSTREAM FLOWS, UPPER MISSISSIPPI REGION

Agency	Authority[a]		Primary Program (function)
		U.S. GOVERNMENT	
DEPARTMENT OF AGRICULTURE			
U.S. Forest Service	I	National Wild and Scenic River Act (P.L. 94-486)	(preserves historical flows of designated streams)
	I	Organic Administration Act of 1897	(establishes National Forests to secure favorable water flow conditions)
DEPARTMENT OF THE ARMY			
Corps of Engineers	I	Clean Water Act, Section 102(b) (P.L. 95-217)	(reserves storage in reservoirs for flow maintenance)
	I	Fish and Wildlife Coordination Act (P.L. 85-264)	(requires consultation with FWS for fishery preservation)
	I	Federal Water Project Recreation Act (P.L. 89-72)	(requires evaluation of recreation potential with projects)
DEPARTMENT OF THE INTERIOR			
U.S. Fish and Wildlife Service	I	Federal Aid in Fish Restoration Act (P.L. 81-681)	(grants for purchase of reservoir storage)
	R	Endangered Species Act of 1973 (P.L. 93-205)	(establishes habitat needs for species protection)
U.S. Geological Survey	S	Act of March 3, 1879	Water Resources Investigations (stream gaging)
National Park Service	I	National Wild and Scenic River Act (P.L. 94-486)	(preserves historical flows of designated streams)
ENVIRONMENTAL PROTECTION AGENCY	S,R	Clean Water Act, Section 303 (P.L. 95-217)	(determines flow needs for water quality) (waste load allocation during critical flow conditions)
	I	Clean Water Act, Section 102(b) (P.L. 95-217)	(evaluate flow augmentation)
FEDERAL ENERGY REGULATORY COMMISSION	R	Federal Power Act	(licenses water-power projects and establishes conditions to maintain flows)
		ILLINOIS	
DEPARTMENT OF TRANSPORTATION			
Division of Water Resources	S	IL Statutes, Chapter 19	(cooperator for Steam Gaging Program and Instream Flow Methodology Study)
	S	IL Statutes, Chapter 19, Section 69	(cooperate with Department of Conservation in improving fish propagation)
		INDIANA	
DEPARTMENT OF NATURAL RESOURCES			
Division of Waters	S	IND Statutes	(cooperator for Stream Gaging Program)
	I	IND Statutes	(adminsters contracts for flow maintenance)
		IOWA	
IOWA GEOLOGICAL SURVEY	S	IA Statutes, Chapter 305	(cooperator for Stream Gaging Program)
NATURAL RESOURCES COUNCIL	S,R, E	IA Statutes, Chapter 455A	(enforces Protected Flow Regulations of the Iowa Water Law)
		MINNESOTA	
DEPARTMENT OF NATURAL RESOURCES	S	MN Statutes, Chapter 105	(cooperator with Department of Transportation for Stream-Gaging Program)
	R,E	MN Statutes, Chapter 105.417	(determines Protected Flows for Water Appropriation Rules)
		MISSOURI	
DEPARTMENT OF NATURAL RESOURCES			
Division of Environmental Quality	S	Senate Bill No. 1, Section 1 (1974)	(cooperator for Stream Gaging Program)
		SOUTH DAKOTA	
DEPARTMENT OF NATURAL RESOURCES DEVELOPMENT	S,R, E	SD Statutes	
Division of Geological Survey			(cooperator for Stream Gaging Program)
Division of Water Rights			Water Appropriation and Permit Program
		WISCONSIN	
DEPARTMENT OF NATURAL RESOURCES	S,R, E	WI Statutes, Chapter 15 and 31	(determines "Public Rights Flow" for Water Appropriation and Permit Program)
GEOLOGICAL AND NATURAL HISTORY SURVEY	S	WI Statutes, Chapter 36	(cooperator for Stream Gaging Program)

[a]Scope of authority is
S= Statutory: research, collect information, coordinate, prepare plans
R= Regulatory: establish rules and regulations, issue permits
E= Enforcement: enforce laws and regulations
I= Implementation/Construction: administer funds, acquire land, construct and operate projects

Sources: Executive Office of the President, Office of Management and Budget, 1979 Catalog of Federal Domestic Assistance, May 1979.
Interagency Task Force--Instream Flows, "Federal Legislation for the Protection and Maintenance of Instream Flows," May 1979.
Upper Mississippi River Basin Commission, FY 1978 Program Report of State and Federal Water and Related Land Resources Efforts, December 1978.
Upper Mississippi River Basin Commission, Upper Mississippi River Main Stem Level B Study, Technical Paper G: Legal and Institutional, August 1979. (draft)

recreation, water quality, aesthetics, and fish and wildlife habitat. The Department of Natural Resouces, Division of Waters can develop and administer contracts for the provision of certain quantities of flow and can develop reservoirs for water supply.

Iowa has state regulations that attempt to preserve a "protected flow" by restricting water use. The Natural Resources Council regulates water use through a permit system for withdrawals in excess of 5,000 gallons per day. Water withdrawal from streams draining 50 or more square miles may be authorized by the permit system, provided the "protected flow," which is the flow exceeded 84 percent of the time during the April-September period, is preserved.

> The protected flow is designed to protect and maintain adequate water supplies for ordinary household and livestock use; for fish and wildlife use; for recreational use; for instream wasteload assimilation and pollution control; for beneficial water use needs in the watershed; for preservation of aesthetic values; and for other uses of a public nature (INRC Rule 580, 3.4, effective November 8, 1978).

Withdrawals from unconsolidated aquifers adjacent to streams also are regulated and specific pumpage restrictions imposed unless testing has verified that groundwater withdrawals will not reduce flows. Streams draining less than 50 square miles have more restrictive regulations. No additional water withdrawals in excess of 200 gallons per minute for consumptive uses will be permitted and many existing consumptive withdrawal permits will not be renewed.

Iowa's regulations are the most specific and restrictive in the Upper Mississippi Region and the protected flow concept is now being extended in Iowa to include lakes.

Minnesota statutes provide for the protection of instream flow needs and intake needs.

> Where data are available, permits to appropriate water from natural and altered natural water courses shall be limited so that consumption appropriations are not made from the water courses during periods of specified low flows in order to safeguard water availability for instream uses and for downstream higher priority users located in reasonable proximity to the site of appropriation (Minnesota Statutes 1977, Chapter 105.417, Subdivision 2).

The Department of Natural Resources regulates appropriation and use of waters and may restrict appropriations when the flow is below the protected flow. Protected flow is defined as the amount of water required in the watercourse to accommodate instream needs for recreation, navigation, aesthetics, fish and wildlife habitat, water quality, and needs by downstream higher priority users.[110] Designated trout streams are protected through issuance of only temporary appropriations during high flows.

The riparian doctrine of Missouri requires that the "natural flow" is protected under the "reasonable use" consideration. "Reasonable use" has been defined by the courts in Missouri through a priority system where "natural" uses are first and "artificial" uses are second. Domestic use and watering of livestock are considered "natural" uses, while "artificial" uses include manufacturing, irrigation, and recreation. Classifying instream recreation as an "artificial" use could pose a problem when instream flow regulations are implemented.

In Wisconsin, the Department of Natural Resources is authorized to protect the "public rights stage or flow" in surface waters.

> The public rights stage or flow is that stage or flow which, in the determination of the department, is necessary to prevent injury to public rights in surface waters. It is the stage or flow required to protect navigation and its incidents; to prevent undue harm to aquatic and wildlife habitat; and to preserve adequate water quality (Wisconsin Statutes, Chapter 30, Section 18).

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[110]Minnesota Department of Natural Resources, Division of Waters, "Proposed Rules for Appropriation of Waters of the State," January 1980.

The Bureau of Water Regulations and Zoning is responsible for issuing permits for the diversion of waters from lakes and streams so that high priority downstream users receive an adequate water supply during low flows.

Wisconsin requires that each person, firm, or corporation maintaining a dam on any navigable stream shall pass at all times at least 25 percent of the "natural low flow" of water of such stream (Wisconsin Statutes, Chapter 31, Section 34). The statute fails, however, to define natural low flow." The Wisconsin DNR generally uses the flow that is exceeded 90 percent of the time as the "natural low flow." For more specific hydrologic studies the 7-day 2-year low flow is used.

While management of instream flows is a state function, the chances of implementing plans and regulations for management will be curtailed without local input. If, for example, a stream or stretch of stream was a good fishery, there would be undoubtedly substantial local support to protect and preserve instream values. Planning to determine "protected or public rights" flows may require coordination with local interests because of different resource needs in river basins or subbasins. A comprehensive statewide management program for instream flows must consider these water needs and resource capabilities.

Alternative Solutions and Effects

The causes for instream flow problems differ throughout the Upper Mississippi Region but the primary issues are the following:

1) Insufficient instream management. Additional research is necessary to determine instream flow needs for most streams.

2) Offstream surface water use competition. Where groundwater resources are insufficient, numerous demands on streams can deplete flows for fish and wildlife.

3) Shallow aquifer pumpage. Shallow groundwater use especially for irrigation can have similar results on low flows as surface water use.

4) Reservoir operations. Prolonged minumum flow releases from reservoirs can stress aquatic life.

5) Rapid surface water runoff. Rapid runoff accentuates the variability between peak flows and low flows.

Recognizing instream flow needs will encourage states to protect and manage flows. Alternatives to attain flow management objectives can be grouped into three main categories: planning and management alternatives, legislative and administrative alternatives, and engineering alternatives (Table II-37). Both the federal and state government have data gathering, planning, and management programs that can provide the framework for reserving instream flows for fish, wildlife, recreation, and water quality. To accomplish improved flow management these basic programs require expansion.

Inadequate data and methodology to quantify economic and environmental values of instream flows limit consideration of instream flow in water resources planning. Data derived from the U.S. Geological Survey's stream gaging program are useful in preparing studies on instream flow needs and further expansion or a network analysis of existing stations might lead to a better delineation of water availability and help determine flow relationships to permanent gages. The surveillance capability of an expanded or improved gaging network could also assist states in enforcing allocation and use requirements.

Additional emphasis on programs of the U.S. Fish and Wildlife Service that study methods for predicting instream flow needs would be beneficial in allocating water for instream needs in federal water projects and in state planning. The Army Corps of Engineers could better manage releases from reservoirs when information is available on the needs of a particular river system. The technical expertise of the U.S. Fish and Wildlife Service can also assist states in selecting streams most suitable for instream management and the best methods for improving instream flow considerations within the existing state laws.

TABLE II-37. ALTERNATIVE SOLUTIONS TO INSTREAM FLOW PROBLEMS AND NEEDS: ANALYSIS AND EVALUATION[a], UPPER MISSISSIPPI REGION

Alternative Solution (Problem Addressed)	Four Account Effects				Evaluation			Conclusion
	NED	EQ	RED	OSE	Planning Objective	Efficiency	Acceptability	
(1) Accelerate the application of methodologies that predict instream flow needs for fish, wildlife, and recreation (Insufficient instream management)	- national cost	+ fish and wildlife habitat + surface water quality + instream flows	- state cost	+ recreation + aesthetics	EQ,NS	High	High	Recommended
(2) Conduct a network analysis of U.S. Geological Survey gaging stations to assess needs and determine optimum placement. More stations or studies may be necessary along streams selected for an instream flow need analysis (Insufficient stream management)	- national cost	+ fish and wildlife habitat + surface water quality + instream flows	- state cost	+ recreation + aesthetics	EQ,NS	High	High	Recommended
(3) Improve coordination between projects and programs of the U.S. Fish and Wildlife Service, Water Resources Council, Army Corps of Engineers and the states to increase consideration of instream flows in all water planning (Insufficient instream management)	+ national cost + navigation	+ fish and wildlife habitat + surface water quality + instream flows	+ water supply + state cost	+ recreation + aesthetics	EQ,NS	High	High	Recommended
(4) Increase designation of streams as Wild and Scenic Rivers (Insufficient stream management; Offstream surface water use competition)	- national cost - non-agricultural output - energy	+ fish and wildlife habitat + surface water quality + instream flows	- jobs - economic stability - water supply - state cost	+ culture + recreation - displacement of home/people + aesthetics	EQ,NS	Medium	Low	Not Recommended
(5) Revise wasteload allocations so that they correspond with minimum flow criteria. The Environmental Protection Agency could consider various alternatives for dealing with wasteload allocations and minimum flows (Insufficient instream management; Offstream water use competition)	+ national cost	+ fish and wildlife habitat + surface water quality + instream flows	XX	+ recreation + aesthetics	NEO	Medium	Medium	Recommended
(6) Establish a protected flow for streams and regulate water withdrawal during low-flow conditions (Insufficient instream management; Offstream surface water use competition; Shallow aquifer pumpage)	- agricultural output - non-agricultural output	+ fish and wildlife habitat + surface water quality + instream flows	- water supply - state cost	+ recreation + aesthetics	EQ,NS	High	Medium	Study
(7) Accelerate implementation of Best Management Practices and wetland preservation to reduce surface runoff and help stabilize instream flows (Rapid surface water runoff)	- national cost + agricultural output	+ fish and wildlife habitat + surface water quality + instream flows + erosion control + sediment contrul	- local cost - state cost + flood damage reduction	+ culture + recreation + aesthetics	EQ,NS	Medium	Medium	Conditionally Recommended
(8) Augment flows with existing or new reservoirs to prevent flows from dropping below some minimum or protected flow (Reservoir operations; Offstream water use competition)	- national cost + non-agricultural output + energy + navigation	+ instream flows - natural areas	+ jobs - local cost - state cost + flood damage reduction	+ recreation - displacement of home/people	NEO	Medium	Medium	Conditionally Recommended
(9) No action	- navigation	- fish and wildlife habitat - instream flows	- water supply	- recreation - aesthetics		Low	Low	Not Recommended

[a]Abbreviations in the Table: NEO (National Economic Development), EQ (Environmental Quality), REO (Regional Economic Development), OSE (Other Social Effects), NS (Nonstructural), XX (Not applicable)

For complete definition of Effects, Planning Objectives, Efficiency, Acceptablility, and Conclusions see Appendix E.

Statewide water plans or planning processes can incorporate instream flow requirements and support legislative proposals that require compliance with the plan. If instream flow values are in plans, then the prospects for attaining a management authority are increased substantially. In addition, these plans should promote the strengthening of the institutional framework that sets priorities and limits for surface water diversions and for withdrawals from aquifers adjacent to streams.[111]

While data collection and planning provide the basis for flow management for instream needs, legislative and administrative alternatives provide a more stringent control mechanism for actually reserving flows for instream needs. Identifying flow requirements of endangered species and inclusion of streams in the National Wild and Scenic Rivers System are federal responsibilities that if expanded could promote

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[111]U.S. Fish and Wildlife Service, Office of Biological Services, Promising Strategies for Reserving Instream Flows, October 1977.

instream flow reservations. The Environmental Protection Agency administers programs for waste treatment requirements and water quality standards that often rely on or affect instream flows.[112] Waste treatment requirements are often based on specific flow levels, so if states are encouraged to develop minimum flow criteria, both the water quality and the instream flow objectives may be realized. The Environmental Protection Agency should consider the three following alternatives for dealing with wasteload allocations and minimum flows.

(1) Base construction grant funds beyond secondary treatment on a flow above the 7-day 10 year low flow where the state has a program to maintain minimum flows.

(2) Clarify EPA policy as to what adequate treatment is as a prerequisite for inclusion of water storage in federal projects.

(3) Coordinate water quality management programs with state water allocation and instream flow programs to develop for stream segments flow and velocity criteria that can be incorporated into the standards.

State agencies may have legislative authority to administer a water allocation system which considers instream flow needs. This water allocation system could establish protected flows for streams with a higher priority use for fishery production, recreation, water quality, or aesthetics after evaluation of instream flow requirements. Offstream water use reduction during critical low-flow periods could minimize low-flow environmental effects in these streams, but flows would sometimes fall below protected flows because natural variability can cause extreme low flows.

Land treatment and preservation of natural wetlands and surface depressions can help stabilize instream flows, in addition to reducing erosion and preserving wildlife habitat. Rapid surface runoff enhances peak flows but ultimately leads to depleted flows during dry periods. State and federal programs that encourage land treatment and wetland preservation can have secondary benefits to instream flows. Artificial recharge of shallow sand and gravel aquifers may also aid in maintaining flows.

Where regulation of offstream water use and drainage is impractical, engineering alternatives that augment or regulate flows are possible. Flow augmentation is already common in part of the region where impoundments are necessary for water supply and flood control purposes. Storage for instream flow purposes could sometimes be increased in these multi-purpose water projects. When storage space becomes available in an existing reservoir, the U.S. Fish and Wildlife Service and state fish and game agencies could negotiate for storage for instream flow purpose under the Fish and Wildlife Coordination Act. Constructing additional reservoirs or enlarging existing reservoirs for instream flow reservations for fish and wildlife needs is also possible under the Clean Water Act, and Fish and Wildlife Coordination Act. Prime reservoir sites could be identified and preserved to satisfy any future demands for instream flows and water supply that necessitate reservoir construction.

Conclusion

While flow augmentation is possible for many streams, costs and environmental repercussions may outweigh the benefits of better managed instream flows. Specific streams should be selected for fish, wildlife, and recreation management, and flow augmentation considered primarily for these streams. However, multi-purpose structural projects must be studied before installation, with instream flow management considered one viable purpose. Since the quantities required to raise flows to higher flow levels are exceptionally large for most streams, augmentation may be generally an impractical solution. Better coordination of reservoir water supply systems could help flow management by diverting water from surplus to deficit areas thus preventing excessive surface water use in some watersheds.

Instream flow management requires

[112] Environmental Protection Agency, Water Planning Division, Water Quality/Water Allocation Study, August 1979. (draft)

further research on the specific effects of low flows on the aquatic environment, on adapting current methodologies to particular streams, and on implementing regulations and alternatives that preserve the stream environment without substantial economic disadvantages and offstream environmental repercussions. Without the implementation of any alternative in instream flow planning (no action), planning for instream flow needs will lag and water appropriation for offstream uses may make it difficult to allocate water for instream needs. Nevertheless, instream flow needs are recognized by all states and some progress in legislation that would incorporate instream flow needs in water use regulations would occur.

PART 3

REGIONAL POLICIES AND RECOMMENDATIONS

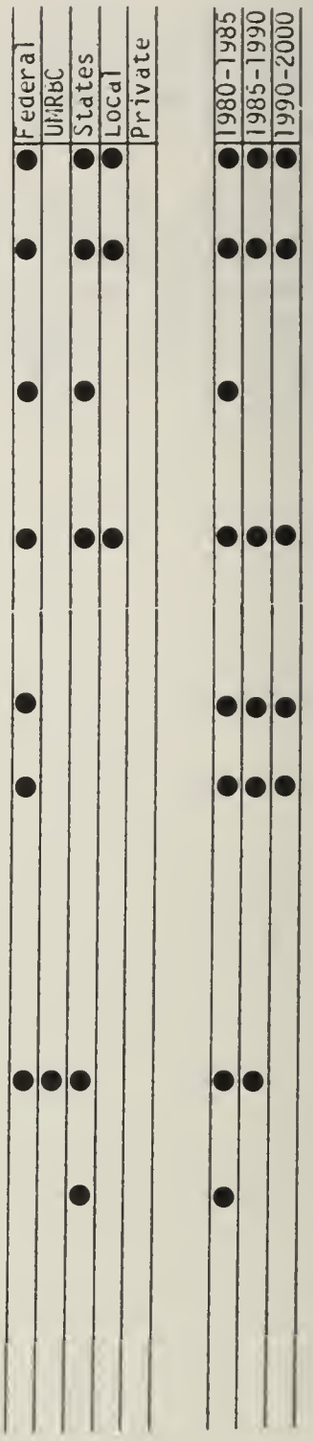
INTRODUCTION

Part 3 is the culmination of this plan and presents specific policies and recommended actions to solve problems and meet needs identified in Part 2. These recommendations were derived from alternative solutions which were evaluated according to "four-account effects," "planning objectives," "efficiency," and "acceptability." Those alternatives judged as most effective in satisfying these criteria are recommended for implementation. Where further evaluation is required before implementation, the alternative was recommended for study. Certain alternatives are conditionally recommended because their implementation is contingent on specific circumstances.

Policies and conclusions are printed in script and followed by recommended solutions derived in Part 2. Specific actions to implement the solutions are listed after each recommendation. The level of government and private involvement necessary for implementation and a priority time frame are indicated in columns adjacent to each recommendation. (Recommendations relative to specific project implementation are listed in the Water Resources Management Plan, Volume II. Upper Mississippi Subregions).

WATER SUPPLY

Local development of water resources can fulfill most supply needs in the region. Federal and state support should be concentrated on monitoring resource quantity and quality and implementing and enforcing legislation to protect supplies.



- Increase programs that monitor water availability, quality, and use.
  - The U.S. Geological Survey through its cooperative program should expand its groundwater monitoring network, and expand, where necessary, and improve the data analysis capability of its stream gaging and water quality networks.
  - States in cooperation with the U.S. Geological Survey should develop systems to collect, store, and disseminate information on water use and make them compatible with other federal and state water use data systems.
  - The U.S. Geological Survey in cooperation with the states or local government should prepare groundwater and surface water inflow-outflow budgets to help in the planning of future development.
- Increase federal support to small water supply systems for improving supply and quality.
  - Such Environmental Protection Agency programs as Drinking Water Supply, State Public Water Systems Supervision Program Grants, and Safe Drinking Water Research and Demonstration Grants, should provide more funds or technical assistance to assist states in improving the quality of local water supplies.
- Reduce groundwater contamination and exploitation through educational and technical programs and better interstate management.
  - An interstate coordination strategy for managing major interstate groundwater systems should be established to alleviate water use conflicts.
- Implement a state water permit system to assure supplies for priority users. All states should implement a water permit system that would require major surface water and groundwater users to apply for a water withdrawal permit. Specific uses excluded from the permit requirements should be determined by each state, but the fewer the exclusions the greater the effectiveness of the system. This would assure better management of water resources and adequate supplies for essential uses.

Water conservation can often reduce water enough to delay costly water development projects and preserve existing resources. Incentives to promote water use efficiency are encouraged at all governmental levels because only a cooperative program will succeed in persuading the public towards conservation.

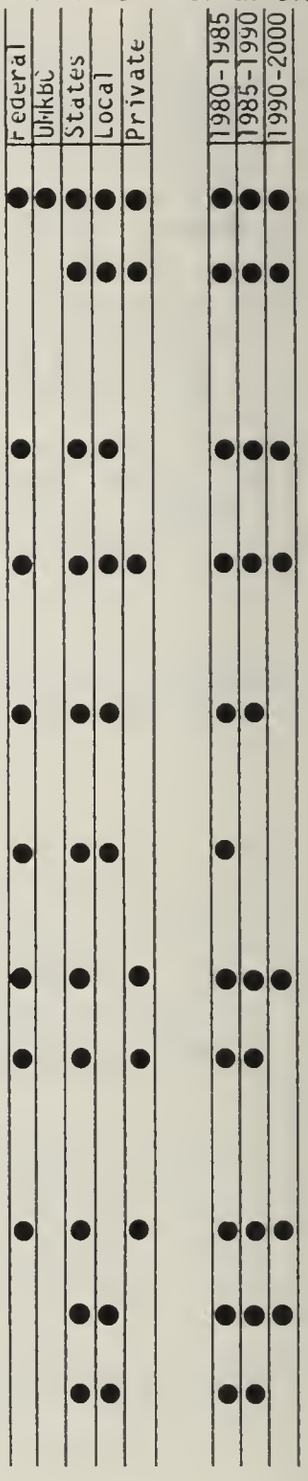
	Federal	UMRBC	States	Local	Private	1980-1985	1985-1990	1990-2000
• Establish a federal conservation program that requires implementation of practical conservation measures before funding or construction, increases financial and technical assistance, and creates a lead conservation agency.	●					●	●	●
• Implement state and local water conservation programs.			●	●	●	●	●	●
- State and local conservation programs should be coordinated with water permit programs and drought planning. Public education on conservation techniques should be fundamental in these programs.			●	●	●	●	●	
- Federal and state funding of local Soil and Water Conservation Districts and such programs as the Soil and Water Loans Program should be accelerated to encourage agricultural water conservation through technical assistance.	●		●	●		●		

Where resources are severely limited, funding for planning and construction must be available to permit development of adequate water supplies. While these problem areas occur throughout the region, they are most evident in the south and west.

	Federal	UMRBC	States	Local	Private	1980-1985	1985-1990	1990-2000
• Federal programs that provide grants and loans for water supply systems must be maintained, but grants and loans should be conditioned on more stringent conservation guidelines that are enforced. Primary grant and loan programs include the Grants and Loans for Public Works and Development Facilities, Community Development Block Grants, and Water and Waste Disposal Systems for Rural Communities.	●					●	●	●
• The possibility of the federal government sharing in the costs for water supply in federal reservoirs should be investigated. This can be accomplished through direct cost-sharing or through allowing state and local government to use their grant money for payment of water supply storage in reservoirs. However, water supply development should be again conditioned on stringent conservation measures.	●					●		
• Additional federal and state funding of regional water supply systems should be allocated for extreme deficit or poor water quality areas. Systems can be expanded and coordinated to assure proper management of available water resources.	●		●			●	●	●
• A study on the need for preserving prime reservoir sites for possible future use through zoning and development restrictions should be conducted in water-deficit areas.	●		●	●		●	●	●
• Create rural water districts to provide good quality water for rural areas. Rural water systems should be encouraged where there exists an inequitable distribution of water.			●	●		●	●	●

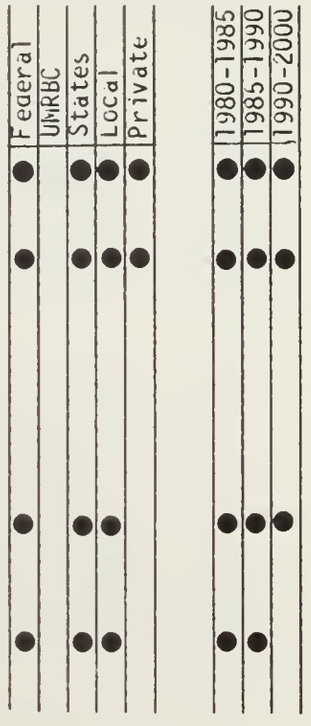
WATER QUALITY

Although nonpoint source pollution is a severe problem in the Upper Mississippi Region, past attention and funding have been directed at controlling point source pollution. Completion of wastewater treatement facilities will not solve all water quality problems because of the agricultural and urban nonpoint contribution. Nonpoint source pollution control measures in the region must be accelerated to improve ambient water quality.



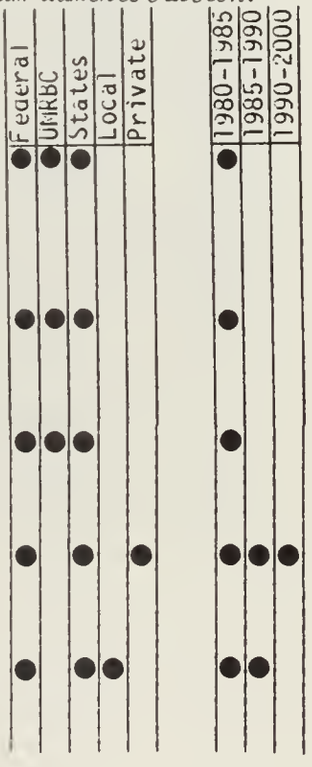
- Accelerate implementation of Best Management Practices recommended under statewide and areawide water quality management plans.
  - States, counties, special purpose districts, and municipalities should accelerate applying Best Management Practices (BMPs) recommended under water quality management plans through tax incentives, cost-sharing, and regulatory mechanisms.
  - Federal funding for the Rural Clean Water Program should be increased to the $400 million authorized level to encourage broad application of BMPs.
  - Funding for the Agricultural Conservation Program and state cost-sharing programs should be increased to assist farmers to install BMPs in order to reduce turbidity and the effects of fertilizer and pesticides carried in sediments.
- Accelerate federal funding for lake restoration projects to improve the quality of lakes and determine the sources of their pollution. In addition, projects should be eligible to receive funding for upland treatment in the watersheds of project lakes.
- Expand educational efforts of state water quality planning agencies to inform the public of low cost and easily applied means for reducing urban and rural nonpoint source pollution.
- Accelerate research on the cause and effects of nonpoint source pollution.
  - The USEPA and state water quality agencies should increase research to determine the effects of rates and timing of fertilizer and pesticide application. Suitable management practices should be determined upon analysis of this information.
  - The USDA should expand research on organic farming technology.
- Accelerate research for the development of efficient urban street sweeping measures and construction site erosion control measures.
  - Local governments and state highway departments should be encouraged to develop improved methods for street sweeping, deicing, and erosion control measures to improve the quality of urban and highway runoff.

With the implementation of the minimum requirements of the Clean Water Act, significant steps will be made in the region toward eliminating or reducing point source pollution problems and thereby improving fish and wildlife habitat, health and safety, and public water supplies. Although current wastewater treatment efforts are necessary and effective, advanced wastewater treatment projects are expensive. Federal and state agencies should increase emphasis on alternatives such as land application and the use of flow augmentation to improve water quality.



- Expand efforts to improve wastewater treatment plant operations, water recycling, and land application.
  - State pollution control agencies, the U.S. Environmental Protection Agency (USEPA), and the private sector should increase efforts aimed at water recycling, cropland application, and the uses of residual sludges and wastewater to enhance crop production, to improve plant efficiency, and to reduce facility costs. Consideration must be given to the composition of wastes to avoid the contamination of soils with hazardous chemicals and heavy metals.
- The USEPA and states should continue to allow streamflow augmentation as an alternative to advanced wastewater treatment in areas where current reservoirs exist and treatment is adequate.
- Funding at the historic level ($4 billion) should be provided to the municipal wastewater treatment plant construction program to accelerate the attainment of the Clean Water Act goals.

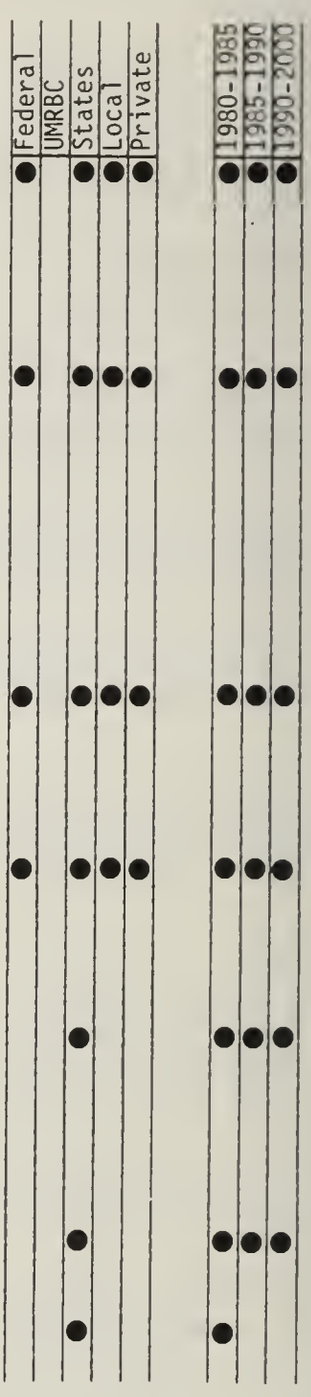
Current water quality management and planning efforts are the responsiblity of several state and federal agencies. The planning and management efforts of these agencies should be coordinated to reduce the overlap between programs and improve the efficiency of program administration.



- Coordinate nonpoint pollution abatement programs of the USEPA and state pollution control agencies with existing soil conservation programs of the U.S. Department of Agriculture and local soil and water conservation districts.
- The states, UMRBC, and USEPA should jointly examine the potential for developing uniform water quality standards for the Mississippi River.
  - USEPA in conjunction with interested states should consider development of new water quality criteria for suspended and deposited sediments in the Upper Mississippi River.
  - The USEPA or delegated state agency should require all NPDES permit holders who must file quarterly thermal monitoring reports to submit these reports in identical format.
  - State and federal agencies should assess the need for additional pump-out facilities and the feasibility of declaring sections of the UMR as "no discharge areas."

EROSION AND SEDIMENTATION

National and state funding for soil conservation programs are disproportionate with the magnitude of the erosion problem. The USDA determined that $50 billion are needed to reduce erosion throughout the region to acceptable levels with an annual need of $1 billion over a 50 year period. Expansion of cost-share funds is necessary to encourage widespread application of conservation practices.



- Accelerate federal funding for the application of land management practices on agricultural land where sheet and gully erosion are severe. Increased funding should be provided to the U.S. Department of Agriculture (USDA) for acceleration of their conservation programs to meet a $1 billion annual soil conservation need.

  - The USDA and similar state programs should be funded to provide additional technical assistance and cost-sharing to agricultural landowners and operators for reducing soil erosion. Special emphasis should be given to incrasing assistance in the critical sediment source areas. The Rural Clean Water Program (RCWP) should be extended and funded to the level previously authorized ($400,000,000 per year), the Agricultural Conservation Program (ACP) funded at $500,000,000 level and technical assistance through local Conservation Districts increased.

  - Existing cost-sharing arrangements of these programs should be expanded to 75-90 percent. Individual project limits should be raised to $7,000 to urge greater public participation. Expanded federal tax incentives should be made available to encourage implementation of land treatment measures.

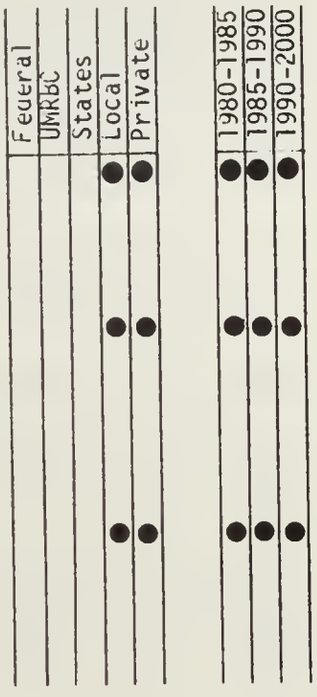
  - States should support the establishment of voluntary "Green Ticket" program whereby farmers would be provided additional tax incentives, larger crop price support payments, additional crop insurance, and lower cost farm loans for practicing soil conservation.

- Accelerate funding of state conservation cost-sharing programs. The programs should supplement the ASCS, Agriculture Conservation Program (ACP) funds to the farm operators for permanent conservation measures. State cost-sharing will raise the eligible funding limit of a project to meet the rapidly escalating costs of conservation measures.

  - Illinois and Missouri should fund their cost-sharing programs at a level commensurate with the erosion problem of the states.

  - Wisconsin should develop and fund an erosion control cost-sharing program similar to programs of Iowa and Minnesota.

The Soil and Water Resources Conservation Act: 1980 Appraisal Part II, (review draft), showed that an expanded level of soil conservation can be achieved that protects the soil resource base and still meets potential agricultural export increases. The accelerated application of soil conservation practices in contingent upon the availability of increased funding to the farm producers and landowners. An erosion control level should be pursued that increases conservation tillage to 85 percent of the region's cropland. Contouring and stripcropping should be practiced on 12 percent of the region's cropland and terracing on 2 percent as a means to conserve agricultural soil without significant economic disadvantages. Forest land grazing should be reduced to 11 percent.

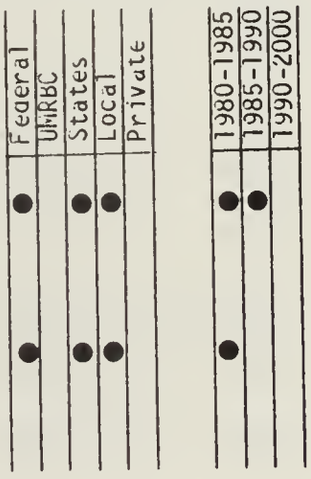


- Adopt conservation practices necessary to attain the economic level which will assure long term production capability. Farmers should seek financial and technical assistance from federal, state, and local soil conservation programs.

  - Cropping practices in the region should be altered as follows: straight row conservation tillage on 47.6 million acres of cropland; contour farming conservation tillage on 5.5 million acres of cropland; stripcropping conservation tillage on 1.2 million acres of cropland; and terraces and conservation tillage on 1 million acres of cropland.

  - Forest landowers should seek financial and technical assistance from federal, state, and local soil conservation programs. Improper forest land grazing should be eliminated on one million acres of forest land.

Critical soil erosion--generally that which is greater than 14 tons per acre--is occurring on 8 millinon acres of land and contributes significantly to the gross erosion tonnage in the region. In addition to financial assistance, technical assistance is needed to identify and treat these areas. Increased technical assistance should be made available to landowners and operators to further identify and treat these critically eroding lands.



- Accelerate the Soil Survey Program to provide information to carry out agricultural land utilization and development programs. The Soil Conservation Service (SCS) should receive $32 million to accelerate the completion of this program.

- Where critical erosion is a widespread problem state soil and water conservation boards should assist local conservation districts in acquiring more funding and staff and to inform the public and give technical advice in soil conservation.

Streambank erosion control projects, small watershed projects, and Resource Conservation and Development areas significantly reduce erosion. Funding levels and financial incentives should be expanded for full implementation of these efforts.

	Federal	UMRBC	States	Local	Private	1980-1985	1985-1990	1990-2000
• Accelerate the application of streambank protection measures such as rip-rapping, streambank crossings, reforestation, and seeding to reduce channel maintenance problems and improve water quality.	●		●	●	●	●	●	●
- The COE should in conjunction with the SCS and state management agencies conduct a study of streambank erosion on the main stem and tributaries of the UMR.	●		●	●	●	●	●	●
- Specific authority and funding should be provided to COE to stabilize a minimum of 5 miles annually following the list in GREAT I. COE should continue restoring and establishing shoreline protection on the main stem and tributaries of the UMR.	●					●	●	●
• Accelerate implementation of P.L. 566 Small Watershed Projects contingent upon the agreement and cooperation of landowners to apply soil conservation on most of the acreage in a watershed. Those projects which will alter or remove wetlands are not supported unless strict mitigative measures are implemented.	●		●	●	●	●	●	●
• Continue financial and technical assitance to sponsors of Resource Conservation and Development (RC&D) areas to inform the public on erosion and to implement controlling measures.	●		●	●	●	●	●	

Sediments cause extensive damages to fish and wildlife habitats, recreational areas, navigation systems, and agricultural lands. Expensive, time consuming, and sometimes harmful measures are needed to restore facilities or to return them to a condition suitable for operations. Even when serious erosion is halted, sediment damages will continue as nature continually erodes the land. Therefore, efforts must be made to mitigate the effects of sediments upon the basin's resources.

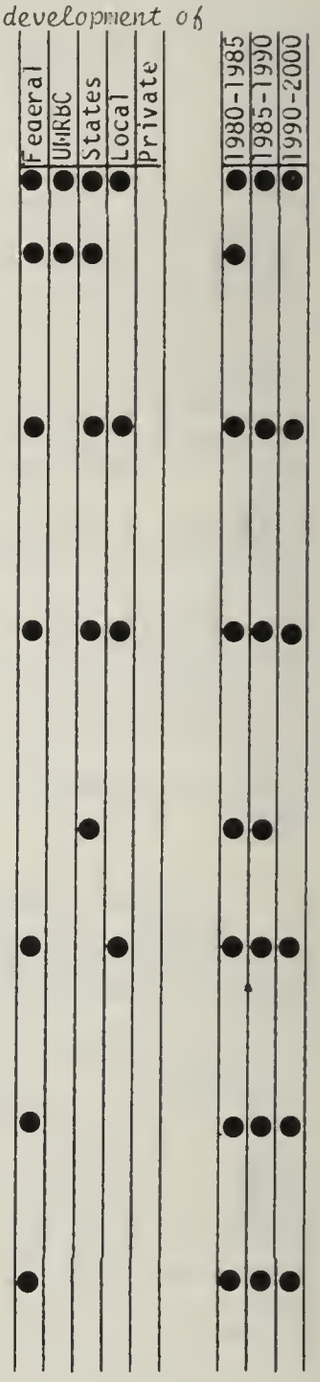
	Federal	UMRBC	States	Local	Private	1980-1985	1985-1990	1990-2000
• Accelerate research to improve the understanding of sediment sources, its transport mechanisms, and its potential beneficial uses.	●		●			●	●	●
- A sediment transport capacity model should be developed to correlate surface erosion rates with carrying capacity, to rate those watersheds with the most serious problems, and to develop a treatment program.	●					●	●	
- The Corps of Engineers should investigate the feasibility of using fine sediments for agricultural purposes.	●			●	●	●	●	
- A plan should be developed to use the river's sediment transport capability to cause necessary dredging requirements to occur near long-term placement sites.	●					●	●	

FLOOD DAMAGE

Protection of existing flood-prone structures through nonstructural measures such as relocation, acquisition, floodproofing, and emergency preparation can be an effective and environmentally sound means to reduce flood damges. These alternatives, where cost-effective, should be strongly encouraged over structural measures.

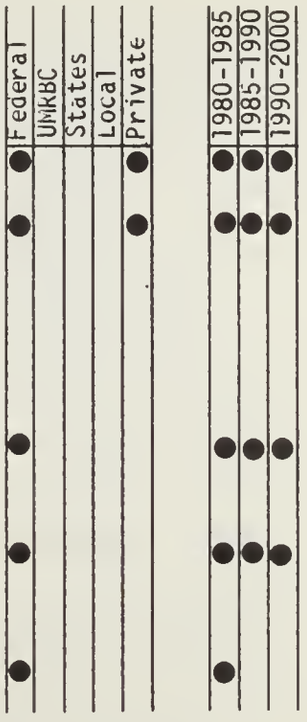
	Federal	UMRBC	States	Local	Private	1980-1985	1985-1990	1990-2000
• Increase acquisition and relocation of flood-prone structures where economically feasible and socially acceptable.	●			●	●	●	●	●
- Programs providing funding for relocation of flood-prone structures should be increased. Programs include the Small Business Administration's Physical Disaster Loan Program, the Department of Housing and Urban Development (HUD) Community Development Block Grant Program, the Flood Insurance Administration's (FIA) Flood Disaster Protection (Section 1362) and Constructive Total Loss Programs.	●				●	●	●	●
• Increase floodproofing where relocation is not practical and flooding is infrequent.	●				●	●	●	●
- The Army Corps of Engineers should increase financial assistance for floodproofing. Such programs as the Discretionary Disaster Fund Program (HUD) and the FIA Flood Disaster Protection Program (Section 1362) should be funded to provide greater financial opportunities for floodproofing.	●				●	●	●	●
• Design emergency flood fighting and evacuation plans and increase participation in local flash flood warning systems.	●			●		●	●	●
- Communities with flash flood hazards should consider investment in National Weather Service (NWS) Flash Flood Alarm Systems. Federal or state financial assistance should be provided through FIA or NWS for highly flood-prone communities to purchase alarm systems.	●			●		●	●	●
- The NWS should receive increased funding for assisting communities in preparing Local Flash Flood Warning Systems and evacuation plans and for improving existing communication systems, radar, and other weather forecast equipment.	●			●		●	●	●
• Make federal and nonfederal cost-sharing formulas for structural and nonstructural measures equal to eliminate the present bias in federal funding and to encourage adoption of floodplain management programs.	●					●		
- Congress should revise cost-sharing arrangements for structural and nonstructural alternatives. Nonfederal interests should be assessed the same cost-share percentage for both alternatives to encourage the most cost-effective strategy.	●					●		
- State participation in federal flood control project planning should be increased to assure adequate consideration of state interests. Federal funds should be made available for this increased state participation. Any state financial contributions to federal flood control project planning and implementation should be commensurate with the level of state planning participation.	●		●			●	●	●

As directed by Executive Order 11988, the long and short-term adverse effects associated with the occupancy and modification of floodplains and the direct and indirect support of floodplain development should be avoided wherever there is a practicable alternative. Management plans for floodplain areas should be established to minimize development of floodplains.



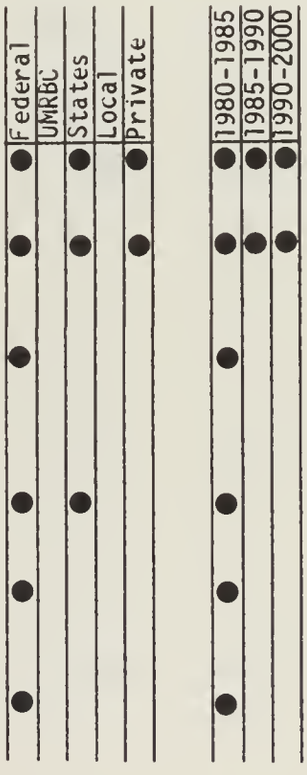
- Accelerate regulation of floodplains to prevent development of floodprone structures.
  - The Feasibility Study for a Math Model of the Upper Mississippi River should be funded. The math model would predict potential changes in flood profiles caused by future management decisions, dredged material disposal, levee construction, and other floodplain development.
  - Financial and technical assistance should be increased for floodplain delineation and subsequent implementation of floodplain ordinances. Federal programs include the Flood Hazard Analysis Program (SCS), the Topographic Mapping Program (USGS), the Floodplain Mapping and Profile Information Program (FEMA), and the Floodplain Management Services (COE).
  - Counties and municipalities with flood problems should participate in the National Flood Insurance Program. Legislation should be enacted in Missouri authorizing third and fourth class counties not adjacent to the Mississippi River to adopt floodplain regulations required for this program.
  - States should coordinate to develop compatible uses of the Mississippi River floodplain.
  - Federal grant and loan programs should place high priority on community acquisition of floodplain land for preservation as open space. Programs include the Community Development Block Grants (HUD), Land and Water Conservation Fund (HCRS), and Community Facilities Loans (FHA).
- Where levees, floodwalls, or channel modifications are necessary to protect urban development, priority should be given to projects that reduce flood damages in developed floodplains. Cost-benefit analyses should not include benefits accrued to future land development in undeveloped floodplain areas.
  - The cost of increasing flood stages and downstream sediment transport capability should be included in cost-benefit analysis for levee and channel modification projects. Mitigation for such effects should be implemented.

Agriculture is compatible with the floodwater storage function of the floodplain and is encouraged by floodplain management programs. The recently expanded Crop Insurance Program will alleviate agricultural flood damge in areas with moderate flood risks. Upstream reservoirs or conversion to other uses compatible with flooding should be considered for areas with high flood risks.



- Convert frequently flooded agricultural land to other uses compatible with the floodplain.
  - Landowners should be encouraged to convert highly flood-prone acreage to recreation facilities, timber production,or wildlife habitat. Specific programs providing assistance include the Recreation Facility Loans (FHA), the Forestry Incentives Program (ASCS), the Water Bank Program (ASCS), and the Pittman-Robertson Program for Wildlife Restoration (USFWS).
- Provide small upstream reservoirs for floodwater storage to reduce agricultural flood damages where valuable fish and wildlife habitat is not damaged.
  - Dry dams should be considered as an alternative to reservoirs to reduce the adverse effects on fish and wildlife and the acreage needed for reservoir sites.
- The use of water-tolerant plants in flood-prone agricultural land should be evaluated by the Department of Agriculture (SCS) to identify alternative crops, their weather and soil requirements, and potential markets.

Levee construction, wetland drainage, and urban expansion onto undeveloped land cumulatively raise flood stages. These activities should be restricted or regulated, since floodplain management and structural measures to prevent flood damages will be ineffective if flood stages increase.

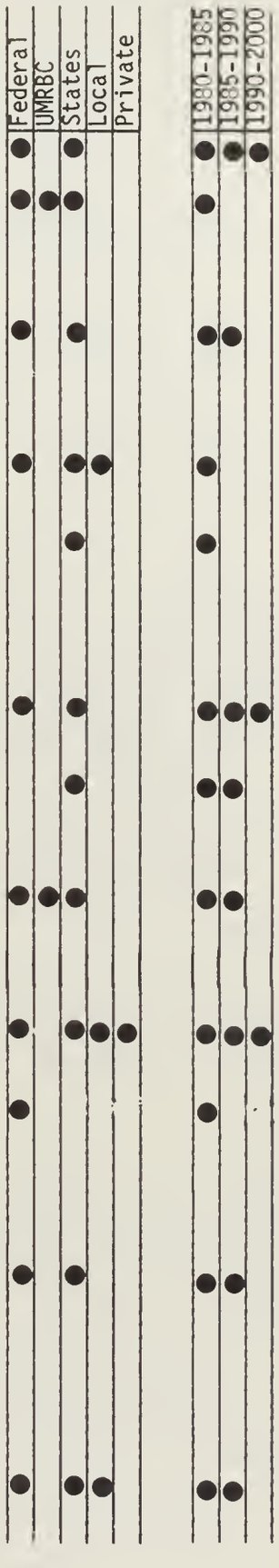


- Curb rising flood stages by restricting cropland drainage, wetland alterations, and floodplain development.
  - Incentives encouraging landowners to preserve wetlands should be increased through state programs and the Federal Water Bank Program (Agricultural Stabilization and Conservation Service).
  - The U.S. Department of Agriculture (USDA), Soil Conservation Service (SCS), should identify alternatives to reduce the effect of cropland drainage on flood stages, such as providing flood storage areas with installation of drainage systems.
  - USDA and state programs to reduce soil erosion and agricultural runoff should be accelerated.
  - Additional studies should be conducted by the Army Corps of Engineers, U.S. Geological Survey, and the SCS to determine the effects of wetland alteration on flood storage.
  - Federal agencies should comply with the Executive Order 11990 and minimize activities affecting wetlands.

	Federal	UMRBC	States	Local	Private	1980-1985	1985-1990	1990-2000
- The SCS and U.S. Fish and Wildlife Service should minimize wetland drainage conflicts resulting from implementation of the Small Watershed Program (P.L. 566) and Fish and Wildlife Coordination Act by coordinating the planning of these activities.	●					●	●	●
- The Corps of Engineers should conduct a quantitative analysis of the effects on Mississippi River flood stages of 1) dredged material disposal and 2) sediment accretion in backwaters and subsequent plant succession in cooperation with the USDA, USFWS, and state agencies. The feasibility of removing material from existing placement sites where there is potential for flood stage impacts should be investigated.	●		●			●	●	
• The restoration of drained wetlands should be evaluated by the SCS as a means to reduce flood peaks.	●					●		
• Adopt stormwater management regulations to prevent increasing flood stages.			●	●		●	●	●
- Counties and municipalities should require installation of stormwater detention measures with new development.				●		●	●	●
- States should establish stormwater management programs prividing technical and financial assistance for communities and setting minimum standards for local stormwater management regulations.		●		●		●	●	

WATER RECREATION

Current and projected demand for recreational lands and facilities exceed supply. As an efficient use of current resources, adequate access to underutilized areas should be provided; as an invaluable investment for the future, areas (land and water) for recreation should be acquired.



- Improve the monitoring and survey of water recreation activities.
  - A regional recreation survey should be conducted to monitor trends, problems, and deficiencies; to supply information to the states; and to expedite the Nationwide Outdoor Recreation Plan.
  - State agencies, with assistance from the U.S. Department of the Interior, should monitor recreation sites to determine underutilized and overutilized recreation facilities and access.
  - Water surface use in pools or portions of pools where conflicts exist should be identified and zoned.
  - Each state should adopt a consistent procedure and timetable with neighboring states in the production of comprehensive recreation surveys to facilitate an integrated plan for recreation use of the Mississippi River and to assist regional and federal agencies in outdoor recreation planning.
- Encourage the use of underutilized recreation areas through information, education, and planning.
  - States should adopt uniform guides and signs for all outdoor recreational areas. Upgrading and adding signs should be assessed.
  - The Upper Mississippi River Basin Commission should coordinate the development of a recreation master plan for the Upper Mississippi River System for implementation by appropriate lead agencies.
- Acquire and develop recreational areas where existing recreational facilities are inadequate for demand.
  - The U.S. Congress should amend the Watershed Protection and Flood Prevention Act (P.L.83-566) and similar legislation that provide government funds for construction of recreation and flood control improvements, to require public access to all impoundments suitable for recreation.
  - The federal Land and Water Conservation Fund appropriations to states should be increased because states are unable to fulfill current needs. States should focus LAWCON and state financial assistance on the acquisition and development of land and surface water areas, shore facilities, and access to improve camping, picnicking, canoeing, fishing, swimming, and waterskiing opportunities.
  - Further studies of private leases on public land should be conducted. Such leases should be phased out when a needed public use can be demonstrated.

	Federal	UMRBC	States	Local	Private	1980-1985	1985-1990	1990-2000
- A system of canoe trails should be developed through selected backwater areas.	●		●			●	●	
- Scenic easements or acquisitions should receive a higher priority in conjunction with implementation of the Great River Road and other applicable state and federal programs.	●		●			●	●	
- The U.S. Congress should authorize the Meramec River National Reserve Act, which would place designated areas under state and local land use controls, to establish the Meramec River Recreation Area.	●		●	●		●		
- The U.S. Congress should authorize and fund the proposed Des Moines River Recreational Access and Greenbelt along the Des Moines River, and designate the U.S. Army Corps of Engineers to manage this area under the tutelage of a state-local advisory committee.	●		●	●		●		
• Increase maintenance or improvement of existing recreational facilities and access.	●		●	●	●	●	●	●
- Efforts should be made to identify and upgrade established access points which, for safe and reliable use, require some physical maintenance or modification.	●		●	●		●		
• Eliminate regulations that impede access to recreation sites or impede movement on recreational waters.	●		●	●	●	●		
- Illinois should expedite the delineation of public waters for recreation and clarify the responsibilities of property owners and the public's right of passage.			●	●	●	●		
- Iowa should provide unimpeded continuous passage on streams by regulating fences across streams and by assisting landowners in the construction of canoe gates and other passage facilities.			●	●	●	●		

Natural areas are irreplaceable and require protection. Strict enforcement of protection measures for our natural resources should lessen their susceptibility to change and damage.

	Federal	UMRBC	States	Local	Private	1980-1985	1985-1990	1990-2000
• Preserve and protect the rivers and streams with the highest recreational values and incorporate water surface zoning (speed and noise) and water surface management policies as part of all comprehensive planning processes.	●		●	●		●	●	●
- The U.S. Department of the Interior should work with state agencies and local governments to initiate hearings and plans for zoning for scenic rivers protection of the riparian lands and the streams which were identified by the HCRS as possible candidates for the National Wild and Scenic Rivers System.	●		●	●		●	●	
- States should adopt and enforce uniform noise levels for recreation boats and other vehicles.			●			●		
- Each state should adopt a wild and scenic river system, similar to the program in Minnesota, to preserve undeveloped rivers and streams not under federal protection.			●	●		●	●	

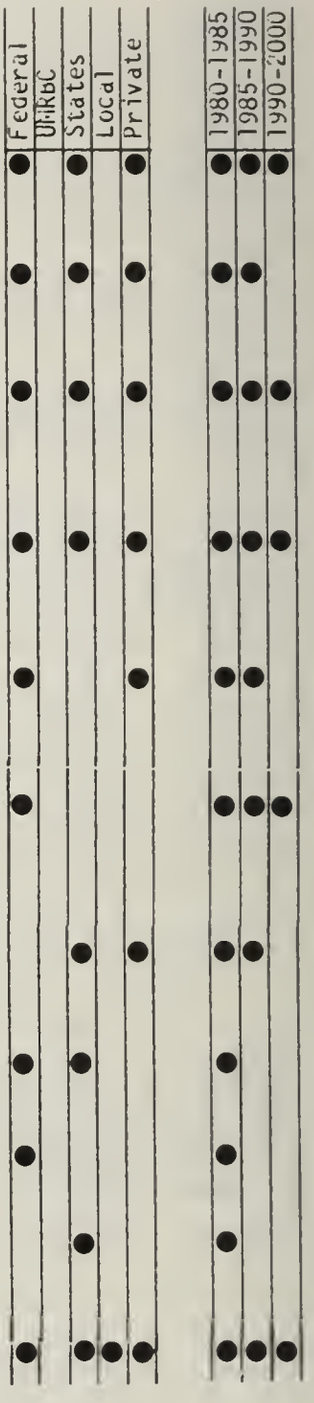
	Federal	UMRBC	States	Local	Private	1980-1985	1985-1990	1990-2000
• Preserve and protect natural areas that are important for recreational and scientific values.	●		●	●	●	●	●	●
- States should preserve and protect biologically and geologically significant natural areas including land and resource waters. Such protection should include endangered and threatened fauna and flora.			●	●		●	●	
- A comprehensive inventory of archeological sites and other "fragile" areas should be developed for use with "environmental impact studies."	●		●			●	●	
- Primitive recreational use sites should be maintained on an interim basis until implementation of comprehensive management plans.			●	●		●	●	
- State and federal agencies responsible for boathouse permits should carefully control and enforce issuance.	●		●			●		

Most water recreational accidents and hazards can be avoided. Safe recreation should be accomplished through program education and enforcement of rules.

	Federal	UMRBC	States	Local	Private	1980-1985	1985-1990	1990-2000
• Increase the enforcement and public education of boating regulations to prevent boating accidents.	●		●	●	●	●	●	
- State and federal agencies, the U.S. Coast Guard Auxiliary, and boating clubs concerned with boating safety should intensify educational programs for recreational boaters.	●	●			●	●	●	
- State or local governments should enact ordinances requiring rental agencies to brief patrons on boat use, local hazards, locking, and rules of the road.			●	●		●	●	
- Greater restrictions concerning boat mooring should be adopted to eliminate lake surface clutter, reduce boating hazards, and resolve conflicts with other interests. Improved lighting requirements for commercial and recreational vehicles should be investigated.	●		●	●	●	●	●	
- Control structures should be marked or modified to reduce hazards to recreational navigation.	●		●			●	●	
- Additional water patrol personnel should be assigned especially in heavily used areas.	●		●			●	●	
- The U.S. Army Corps of Engineers should develop individual pool navigation charts for recreation boaters.	●					●		
• "Lockage waiting areas" at each lock and dam should be considered for development to reduce hazards associated with recreational boat traffic through lockages.	●		●			●	●	

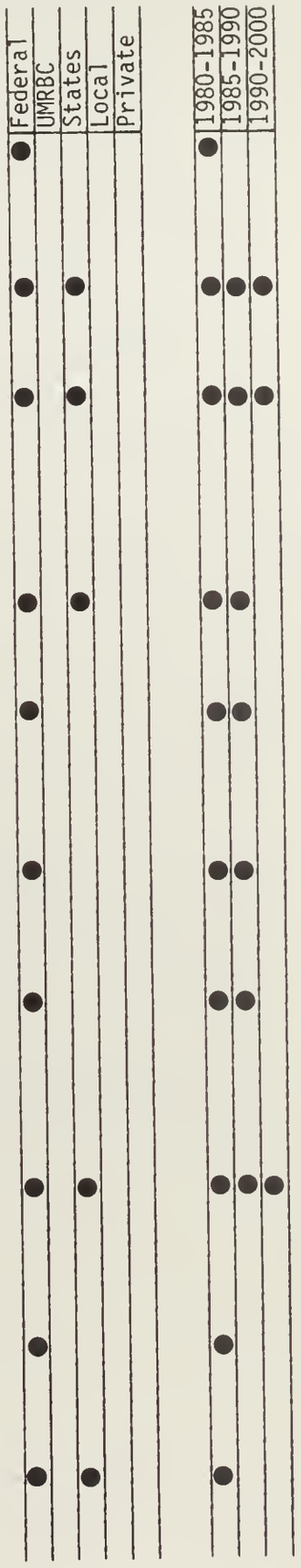
FISH AND WILDLIFE

As a result of extensive drainage, wetland acreage has been severely diminished. Accurate information on wetland drainage is lacking, but estimates indicate that in most areas of the region less than ten percent of the original wetlands remain. Wetlands are areas of great value, providing natural flood control, improved water quality, stablization of stream flows, and fish and wildlife habitat. Pursuant to Executive Order 11990, wetlands should be protected.



- Accelerate the acquisition of remaining wildlife habitat, expecially the fee title acquisition of high quality wetlands and critical habitats of threatened and endangered species.
  - The U.S. Fish and Wildlife Service (USFWS) and the states should index their migratory waterfowl stamp prices to land prices.
  - Federal and state agencies should increase their efforts to solicit support from private interest groups such as the Nature Conservancy, National Wildlife Federation, and National Audobon Society to acquire high quality habitat.
- Promote wetland preservation by landowners through increasing incentives for participation in water bank programs, and by granting tax credits to landowners with wetlands on their property.
  - The U.S. Department of Agriculture should seek additional funding to increase payments to landowners who participate in the Federal Water Bank Program.
  - The Agricultural Stabilization and Conservation Service should improve its coordination with states in allocating Agricultural Conservation Practices (ACP) funds for construction of shallow basins and planting permanent wildlife cover.
  - Illinois, Iowa, Missouri, and Wisconsin should institute state water bank programs and tax credit programs to encourage wetland preservation by landowners.
- Complete wetland inventories as soon as possible, to assist in fish and wildlife planning, research, and management.
  - Congress should provide the USFWS with additional funding to accelerate completion of the National Wetlands Inventory.
  - States should institute wetland inventories similar to Wisconsin's, to aid in statewide planning, and also to assist the USFWS with the National Wetlands Inventory.
- Fish and wildlife production should be enhanced through the application of forest management techniques in the river basin.

Navigation and associated channel maintenance activities (dredging, channel alteration, pool level fluctuation, barge fleeting) have degraded fish and wildlife habitat. There is an urgent need for detailed information regarding the effects of navigation activites, and for measures which mitigate these effects.



- Congress should provide Corps of Engineers with definitive authority and funding to assist the Fish and Wildlife Service and states in accomplishing fish and wildlife conservation and recreation projects.

- Increase research on the biological and physical features of the Mississippi River, especially to aid in determining the effects of habitat alteration.

  - The USFWS, in cooperation with state and other federal natural resource management agencies should: (1) complete studies that collect information on the distribution, abundance, population characteristics, and harvest of all fish and wildlife species in the Mississippi River; and (2) inventory and map the distribution of submerged aquatic vegetation, invertebrates (including clams), bottom types, and other physical features.

  - The state management agencies, the COE and the USFWS, should develop and complete a natural history survey to identify those natural, scenic and cultural areas needing protection.

  - The COE should conduct detailed pool-by-pool cross section surveys, including off channel areas, on an annual basis. These data could be used to develop and implement programs to rehabilitate critical backwater areas.

- The COE should initiate a pilot project to determine the feasibility and environmental considerations for dredging and island creation in a backwater area to restore fish and wildlife habitat.

  - The COE should: 1) initiate a pilot project to determine the feasibility and environmental considerations for dredging a backwater area; 2) refine the capability to predict the biological consequences of physical alterations to side channels and backwaters; and 3) complete the priority 1B backwater alterations.

- The COE should undertake studies in coordination with state and federal resource agencies to assess the environmental and economic impacts of barge fleeting on the Mississippi River. These studies should be used to identify fleeting sites and measures which will protect fish and wildlife resources.

- The COE should study means of controlling pool water levels for the benefit of fish and wildlife and recreation in harmony with the 9-foot channel project. This study should address the potential effects of relocating pool control points.

- State and Federal Agencies should seek modification of their laws and requirements to allow creation and maintenance of interagency recommended recreation and fish and wildlife enhancement within the floodplain.

Populations of certain wildlife species have been reduced because of problems related to increased demand, introduction of harmful exotic species, and lead shot poisoning. On the other hand, nongame (including endangered) species are suffering from a lack of program funding. Federal and state agencies must cooperate to provide protection and funding for game and nongame fish and wildlife throughout the region.

	Federal	UMRBC	States	Local	Private	1980-1985	1985-1990	1990-2000
• Increase funding for sport fish restoration and management.	●		●			●	●	●
- Congress should pass a Dingell-Johnson Expansion Bill, to provide up to five times the current federal funds available to states for sport fish restoration and management.	●					●		
- Cost allocation programs for user/beneficiaries should be developed by appropriate agencies in managing water resources.	●		●			●		
• The states should adopt restrictions proposed by the USFWS on the use of toxic lead shot for waterfowl hunting in areas where waterfowl are particularly susceptible to lead shot poisoning. These areas are mutually identified by the states and the USFWS.	●		●			●	●	
• Federal and state agencies should analyze all proposed introductions of exotic organisms to determine their compatibility with native communities.	●		●			●	●	●
• Increase emphasis on nongame fish and wildlife research and management, especially programs involving endangered and threatened species.	●		●			●	●	●
- Congress and the states should increase funding for nongame fish and wildlife programs, particularly those involving the reintroduction of extirpated species.	●		●			●	●	●
- The USFWS, in cooperation with state and other federal agencies, should develop a program to monitor federal and state endangered and threatened species. Particular emphasis should be placed on habitat utilization within the Mississippi River floodplain so that habitat management techniques can be developed.	●		●			●	●	●
- Each state and Federal agency contributing to the natural resource management of the Upper Mississippi River should place more emphasis on the river by increasing staff and budget allocations to the work on the fish and wildlife resources on the river.	●		●			●	●	●

The riverine environment is sometimes threatened by methods used in the production, storage and transport of hazardous materials. Procedures should be used which will minimize the adverse effects on water quality associated with navigation and toxic substances.

	Federal	UMRBC	States	Local	Private	1980-1985	1985-1990	1990-2000
• Monitor and regulate hazardous materials which are being transported, produced, or stored on or near the river.	●		●	●	●	●	●	●
- The Environmental Protection Agency should maintain a list of all substances that would significantly threaten the riverine environment if a spill occurred. The U.S. Coast Guard should continue to develop and enforce regulations on the shipment of hazardous materials including prohibition, when necessary.	●				●	●		
- All industries located in the floodplain, which produce or store toxic materials should be floodproofed to the standard project flood.	●		●	●	●	●	●	
- The states with the assistance of the USEPA, should implement industrial waste pretreatement and resource recovery programs.	●			●	●	●	●	●
- The Federal Railroad Administration should place a high priority on safety enforcement efforts on lines along the Upper Mississippi River.	●		●	●	●	●	●	●

COMMERCIAL NAVIGATION

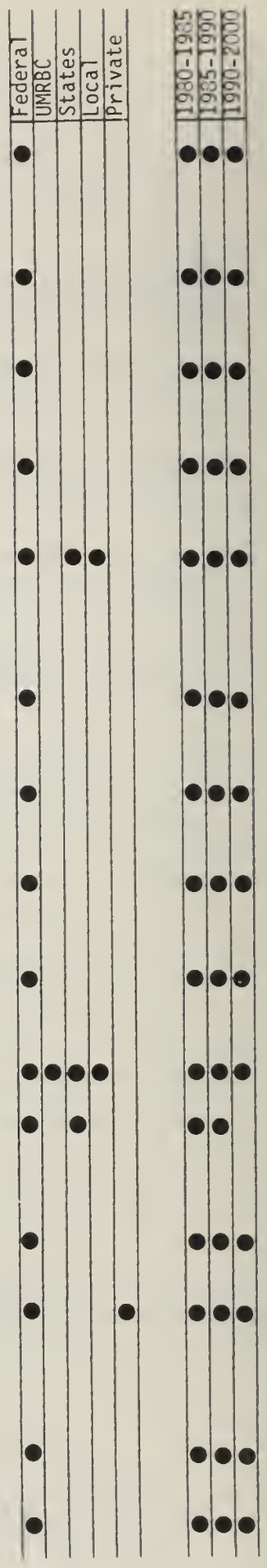
The growth of navigation traffic on the Mississippi River is constrained by inadequate lock capacity, terminals, and fleeting areas. Expansion of the system to accommodate demands has been met with opposition because of effects on recreation, water quality, and fish and wildlife resources. Economic and environmental goals for the Upper Mississippi River need to be determined and measures identified to improve the navigation system while safeguarding the environment.

	Federal	UMRBC	States	Local	Private	1980-1985	1985-1990	1990-2000
• Federal and state agencies concerned with river management should continue to coordinate their activities through an ongoing interagency management coordination team.	●	●	●			●	●	●
• The Army Corps of Engineers (COE) should continue a program to conduct advanced planning of the Upper Mississippi River navigation system so that locks whose capacity will be exceeded can be identified and studied.	●					●	●	●
• Implement efficiency measures to increase capacity of the navigation system.	●		●		●	●	●	●
- Traffic control measures and equipment scheduling at locks should be evaluated as means to increase efficiency.	●	●	●			●		
- The COE should provide average lock processing times for each lock to the barge and towing industry to improve the training of barge crews.	●				●	●		
• Increase safety for commercial and recreational traffic.	●					●	●	●
- The U.S. Coast Guard (USCG) should improve its navigation aids program by increasing personnel, improving equipment, and increasing coordination with the COE and the public to identify hazardous areas.	●					●	●	
- Studies should be conducted to determine the need for improved lighting methods for night barge operations.	●					●		
- The COE should install information signs at locks designating specific locking times for recreational craft, where appropriate, and commercial vessels to avoid congestion. The COE should monitor lockages to ensure the proper application of existing lockage regulations.	●					●		
- Control structures should be marked or modified where appropriate to reduce hazards to recreational navigation.	●					●		
- The USCG should, in cooperation with the COE, undertake an inventory of commercial and recreational navigation hazards in river segments with a history of frequent accidents. Measures to eliminate hazards should be identified and implemented.	●					●		
- So that operating regulations for fixed and opening bridges can be vigorously enforced by the USCG, the Acts of August 18, 1864, and March 3, 1899; the Bridge Act of 1906; and the General Bridge Act of 1946 should be amended to provide for civil penalties.	●					●		
- The USCG should improve the detectability of bridge piers and the navigation aids on approaches to bridges.	●					●		

	Federal	UMRBC	States	Local	Private	1980-1985	1985-1990	1990-2000
- The Truman Hobbs Act should continue to be used to rebuild bridges for navigation needs and be amended to include replacement or repair of bridge protection systems and to include benefits to land as well as marine interests.	●					●		
• Develop terminals and fleeting areas required for existing and future traffic while minimizing effects on environmental, recreational, and cultural resources.	●		●	●	●	●	●	●
- Concentrating industrial development in the form of commercial terminal complexes should be encouraged through tax incentives or through land use plans as a means to limit strip development.	●			●		●	●	●
- The state and federal Departments of Transportation should develop policies which focus on and promote intermodal transportation systems.	●		●			●	●	●
- Rail service and highway capacity to port areas should be increased to develop an efficient intermodal transportation system.	●		●	●		●	●	●
- A study to identify acceptable fleeting areas to meet present regional shortages and future regional needs should be conducted.	●		●			●	●	
- States, regional planning agencies, and local agencies should coordinate efforts to develop riverfront land use plans to accommodate port development, recreation, and fish and wildlife habitat. Such plans should be coordinated with adjacent states to avoid conflicting land use designations.		●	●	●		●	●	
- Studies to identify environmental and economic effects of barge fleeting sites should be conducted.	●		●			●	●	
- Congress should direct the U.S. Department of Transportation or the COE to review federal, state, and local regulations with a view toward defining more clearly the areas of jurisdiction and proposing the elimination of jurisdictional conflict areas.	●		●	●		●	●	
- Local port districts should be established at transportaion centers to develop or promote development of needed harbors, fleeting areas, and rail-barge transfer facilities.			●	●		●	●	
- The COE should seek authority to identify and rehabilitate those harbors and access areas which suffer from severe sedimentation.	●					●	●	●

Sediments deposited in the navigation channel must be dredged periodically to allow for safe passage of tows. The effects of dredging and dredged material disposal on fish and wildlife, recreational resources, and water quality should be mitigated.

	Federal	UMRBC	States	Local	Private	1980-1985	1985-1990	1990-2000
• Reduce dredging requirements and subsequent disposal problems by limiting the depth of dredging where cost efficient.	●					●		



- Average annual dredging quantities should be minimized through application of technically supported reduced-depth dredging and maintenance of minimum channel widths suitable for safe navigation.

- The COE should continue to develop computerized sediment transport models of the Mississippi River 9-foot navigation system.

- Donate or sell dredged material for productive uses, where cost efficient, to prevent problems resulting from disposal of materials in the floodplain.

  - The COE should sell dredged materials to sand and gravel companies or donate material when needed to other governmental agencies or non-profit organizations.

  - Material dredged during channel maintenance should be placed at areas accessible for removal for beneficial purposes where technically and economically feasible. A process should be developed to quickly identify and use new placement sites in order to satisfy new demands.

  - The COE should change its policy and allow acquisition of private lands for stockpiling dredged material where beneficial uses exist.

  - The COE should investigate the possibility of sand and gravel companies accomplishing the dredging required for channel maintenance.

- Congress should continue to authorize the maintenance of the navigation channel to meet current and future needs of commercial navigation consistent with other resource requirements.

  - The COE should be funded to prepare site development plans for historic and proposed dredged material disposal sites to prevent erosion and enhance recreation and fish and wildlife habitat.

  - The GREAT II channel maintenance plan should be implemented.

  - The COE, in cooperation with the U.S. Fish and Wildlife Service and state agencies, should conduct a study of riverine disposal operations to determine the destination of the deposited materials.

  - Until the COE can fully implement the GREAT I material placement plan, interim guidelines for placement should be followed.

  - Temporary material placement sites approved in the GREAT I process should be used when private or government dredging capability to reach the GREAT I recommended channel maintenance plan sites is not expected to be available before dredging is required.

  - The COE should monitor dredging and material placement to further determine impacts on water quality.

  - The COE should request funding to utilize through contract or purchase the most efficient equipment available to reduce adverse effects of dredging and disposal.

	Federal	UMRBC	State	Local	Private	1980-1985	1985-1990	1990-2000
- A demonstration dredging project should be conducted by the COE to determine the feasibility and cost effectiveness of accomplishing channel maintenance by various mechanical and hydraulic dredging and unloading methods.	●					●		
- The COE should maintain sufficient dredging capability to perform emergency and national defense dredging.	●					●	●	●
- Emergency dredging definitions developed through the Great River Environmental Action Teams (GREATs I and II) should be adopted.	●					●		

ENERGY

Large-scale steam-electric generation, which is the region's largest water user, will continue to produce most of the region's power. Measures that reduce effects of steam-electric generation on water resources should receive greater emphasis during development planning.

	Federal	UMRBC	States	Local	Private	1980-1985	1985-1990	1990-2000
• Promote district heating and industrial uses of waste heat for existing and scheduled steam-electric plants.	●		●	●	●	●	●	●
- States should identify opportunities for utilizing waste heat, conduct feasibility studies, and provide economic assistance for cogeneration projects.			●			●	●	
• Develop power production at smaller-scale (200-400 MW) steam-electric plants as an alternative to large-scale power plants. The states and utilities should consider small-scale plants that reduce effects on water resources, produce power closer to the populations served, and increase opportunities for utilizing cogenerating and district heating.			●		●	●	●	●
• A study should be conducted on the feasibility of once-through cooling to supplement closed cycle-cooling for steam-electric plants scheduled on the Mississippi River and major tributaries.			●		●	●		
• Study the potential for acid rain from coal fired steam-electric plants to determine the need for stricter air quality standards.	●		●		●	●		

Expanded use of alternative energy sources and conservation is necessary to help meet electrical demand and reduce the need for projected steam-electric generation and its associated water use.

	Federal	UMRBC	States	Local	Private	1980-1985	1985-1990	1990-2000
• Increase incentives for implementing energy conservation measures. Federal and state government should increase tax credits, penalties, and technical assistance to encourage more efficient building codes, thermostat regulations, and other conservation measures.	●		●			●	●	●
• Develop alternative energy sources (hydroelectric, solar, and biomass) through increased tax credits, low interest loans, direct subsidy, building codes, and technical assistance.	●		●	●		●	●	
• Inventory and evaluate hydroelectric power potential in the Upper Mississippi Region in terms of the economic, environmental, and institutional constraints that may limit further development. The Corps of Engineers should cooperate with the states to identify mutually acceptable hydroelectric power objectives and to implement projects to meet those objectives	●		●			●	●	●
• Study the potential for industrial generation of electricity, especially in urban areas, by utilizing waste "process heat" generated in many industrial processes. States should identify industries with electrical potential and facilitate cooperation between industry and utilities.	●		●		●	●	●	●

Increased emphasis on the use of biomass and coal will encourage the development of steam-electric, gasohol, and coal conversion plants which should be planned and sited to minimize their effects on water resources and to avoid conflicts between competing uses.

	Federal	UMRBC	States	Local	Private	1980-1985	1985-1990	1990-2000
• Require water consumptive energy facilities (steam-electric, gasohol, and coal conversion plants) to be sited where water supply is adequate to minimize conflicts between competing uses and other water resource needs.	●		●			●	●	●
- States should develop a procedure for siting water consumptive energy facilities that considers the need for plants, water requirements, and potential sites.			●			●		
- States should cooperate in siting large-scale energy facilities.			●			●	●	●

INSTREAM FLOWS

Instream flows are a vital use of water that must be acknowledged in water planning. Federal support should be concentrated on further instream flow data collection and research, and on incorporating instream flow needs in federal project and wasteload allocation planning.

	Federal	UMRBC	States	Local	Private	1980-1985	1985-1990	1990-2000
• Accelerate the application of methodologies that predict instream flow needs for fish, wildlife, and recreation.	●		●			●	●	●
- The U.S. Fish and Wildlife Service should expand instream flow research in its Water Resources Analysis Activity Program and other biological services programs:	●		●			●	●	
a) to corroborate existing techniques that establish instream flow limits for fish, wildlife, and recreation;								
b) to establish a standard methodology that would determine the desired flow regimen for any stream; and								
c) to determine the best method for attaining instream flow needs for selected streams which would be managed for fish, wildlife, and recreation.								
- States should cooperate with the U.S. Geological Survey, U.S. Fish and Wildlife Service, and U.S. Army Corps of Engineers in expanding and improving the monitoring necessary to implement instream flow needs methodologies.	●		●			●	●	
• Conduct a network analysis of U.S. Geological Survey gaging stations to assess needs and determine optimum placement. The U.S. Geological Survey through its cooperative program should consult with federal, regional, and state agencies on specific data collection needs for instream flow analyses.	●		●			●	●	
• Improve coordination between projects and programs of the U.S. Fish and Wildlife Service, Water Resources Council, Army Corps of Engineers, and the states to increase consideration of instream flows in all water planning. The "Principles and Standards" developed by the Water Resources Council should increasingly stress the economic and environmental benefits of instream flow preservation.	●	●	●			●		
• Revise wasteload allocations so that they correspond with minimum flow criteria.	●		●			●	●	
- The U.S. Environmental Protection Agency should develop a program that encourages states to establish a process for identifying specific stream segments for which flow criteria will be developed. Coordination between state agencies developing water quality standards and agencies protecting instream uses is necessary to minimize conflicts between Clean Water Act programs and state water law.	●					●		

States have the ultimate authority for protecting instream flows. Current flow regulations in the region vary in effectiveness and enforcement. States should support research and implement legislation for achieving flow protection.

	Federal	UMRBC	States	Local	Private	1980-1985	1985-1990	1990-2000
• States should initiate or expand studies on procedures to establish a protected flow for streams and to regulate water withdrawal during low-flow conditions.			●	●	●	●	●	●
- Each state should formulate a plan for instream water uses which considers competing uses and allocates the available water resources. A water use priority system should be implemented by the state during critical low-flow periods.			●			●	●	
- States should establish a procedure for determining protected flows particularly for streams with fish, wildlife, and recreation values.			●			●	●	
- Where a water use priority system exists, states must require municipalities, industries, and other major water users to adopt water conservation measures during low-flow periods.			●	●	●	●	●	●
• Where surface water runoff is rapid, implementation of Best Management Practices and other water retention methods should be accelerated to increase surface infiltration.	●		●	●	●	●	●	●

Flow augmentation from existing reservoirs should stress instream needs for waste assimilation as well as for fish, wildlife, and recreation. Augmentation is recommended when instream resources are severely threatened with persistent low flows or to improve the development of instream resources.

	Federal	UMRBC	States	Local	Private	1980-1985	1985-1990	1990-2000
• Reservoirs that provide some augmentation capability should continue that function, but methods to improve the water quality of their releases should be investigated by the Army Corps of Engineers, Soil Conservation Service, and responsible state agencies.	●		●			●	●	●
• The Army Corps of Engineers and the states should examine reservoir operations to determine if periodic increases above the minimum flow release are possible.	●		●			●	●	●
• Federal and state agencies should more efficiently manage surface water systems to resolve conflicts between water quantity and water quality needs. The feasibility of constructing additional reservoirs to improve flow management and provide more water throughout the year should be studied carefully to assure optimal environmental and economic benefits.	●		●			●	●	●

PART 4

ENVIRONMENTAL ASSESSMENT SUMMARY

EFFECTS OF RECOMMENDED SOLUTIONS ON OBJECTIVES FOR WATER AND RELATED LAND RESOURCES

Throughout the discussion in Part 2, references were made to the complex relationships among the nine functional topics of water and related resources. For example: deteriorating water quality affects water supply, impairs water recreation, and threatens fish and wildlife habitat; wind and water erosion increase sedimentation that impairs water quality.

The recommended solutions "will" or "may" affect the objectives of many of the nine functional areas (Table IV-1). These relationships are either positive (+) or negative(-): where the effects are negative, mitigating measures are stated in parentheses.

The majority of the effects are positive. For example, implementation of Best Management Practices to enhance water quality in the Upper Mississippi Region may also reduce erosion and sedimentation. In ten cases, the effects of recommended solutions on the objectives for the functional topics are negative, four of which provide mitigating measures:

- additional supply development from surface water and shallow sand and gravel aquifers may reduce flows (mitigative measure: water permits and "protected flow" regulations should mitigate this effect)
- unless carefully monitored and tested, substances such as heavy metals may contaminate soils, groundwater, or runoff (evaluation of sludge, wastewater, and solid waste disposal is necessary before application)
- some habitat may be altered or destroyed by P.L. 566 Watershed Projects (mitigative measures may be provided)
- "protected flow" regulations will restrict water use (conservation measures may minimize effect)

Six of the negative effects of these solutions on the functional topics do not provide for mitigating measures but their benefits surpass disadvantages:

- conservation tillage may require more fertilizers and pesticides and therefore increase the occurrence of contamination
- channel modification may increase erosion
- upstream reservoirs, channel modification, and levee construction may damage fish and wildlife habitat
- development of access and facilities in recreation areas at underutilized sites will disrupt habitat and disturb an area's natural state
- additional fleeting and terminal areas would disturb habitat
- small upstream impoundments will increase evaporation

TABLE IV-1 EFFECTS OF RECOMMENDED

Recommeded Solutions for \ Objectives for	WATER SUPPLY	WA	ENERGY	INSTREAM FLOW
WATER SUPPLY		- Additiona may incre reduce as of stream + Conservat programs quality d of the gr		- Additional supply development from surface water and shallow sand and gravel aquifers may reduce flows (water permits and "protected flow" regulations should mitigate this effect)
WATER QUALITY	+ Wastewater treatment measures and Best Management Practices (BMPs) will improve the quality of available supplies			+ BMPs on agricultural land will reduce rapid runoff and stabilize instream flows + Flow augmentation may improve the quality of instream flows and improve fisheries conditions
EROSION AND SEDIMENTATION	+ Soil conservation measures will reduce rapid runoff and improve infiltration into aquifers	+ Erosion a improve u + Soil conse retain so pesticide - Conservat more fert + Streamban improve wa	sures re-hannel	+ Small instream impoundments implemented through P.L. 566 Waterhshed Projects may stabilize instream flows - Small upstream impoundments will increase evaporation
FLOOD DAMAGE	+ Decreasing runoff rates through stormwater management, flood-plain and wetland preservation, and land treatment will improve aquifer recharge capability	+ Wetland p restorati preservat will main by contin		+ Upstream reservoirs would maintain instream flows + Maintaining floodwater storage would stabilize instream flows
WATER RECREATION		+ Preservat of additi prevent w tions fro river val streamban + Monitorin will iden problem a recreatio	s and s con-reas, nd con-ce con-al and	
FISH AND WILDLIFE	+ Wetland preservation will maintain aquifer recharge capability	+ Wetland p maintain filtratio of water		+ Wetland preservation will prevent further acceleration of surface water runoff and resultant flow fluctuation
NAVIGATION		+ Use of ef ment and re-erosio channel w quality		
ENERGY[v]	+ Alternative energy sources will reduce the projected demand for steam-electric generation and water consumption + Conservation will reduce electrical generation and enhance water supply	+ A study o acid rain electric stricter and impro		+ Alternative energy sources will reduce the projected demand for steam-electric generation and enhance instream flows + Power production at smaller steam-electric plants may reduce effects on stream flow
INSTREAM FLOW	- "Protected flow" regulations will restrict water use (conservation measures may minimize effect)	+ Instream maintain capacity costs of treatmen	+ Instream flow analysis will aid in siting steam-electric plants	

+ positive effect
- negative effect
( ) mitigative measure

TABLE IV-1 EFFECTS OF RECOMMENDED SOLUTIONS ON OBJECTIVES FOR WATER AND RELATED LAND RESOURCES, UPPER MISSISSIPPI REGION

Recommended Solutions for \ Objectives for	WATER SUPPLY	WATER QUALITY	EROSION AND SEDIMENTATION	FLOOD DAMAGE	WATER RECREATION	FISH AND WILDLIFE	NAVIGATION	ENERGY	INSTREAM FLOW
WATER SUPPLY		- Additional supply development may increase surface use and reduce assimilative capacity of streams + Conservation and educational programs will help reduce quality degradation especially of the groundwater	+ Preserving reservoir sites will limit adverse land use development	+ Preserving reservoir sites will reduce development in flood-prone areas					- Additional supply development from surface water and shallow sand and gravel aquifers may reduce flows (water permits and "protected flow" regulations should mitigate this effect)
WATER QUALITY	+ Wastewater treatment measures and Best Management Practices (BMPs) will improve the quality of available supplies		+ Some BMPs may reduce erosion and sedimentation + Disposal of wastewater and residual sludges on agricultural land may benefit production - Heavy metals and other chemicals may contaminate soils, groundwater or runoff (evaluation is necessary before application)		+ Upgrading of wastewater treatment and the widespread application of BMPs will enhance recreation on lakes in the region	+ Wastewater treatment facilities and BMPs will enhance habitat + Expanded financial assistance for feedlot controls will improve habitat			+ BMPs on agricultural land will reduce rapid runoff and stabilize instream flows + Flow augmentation may improve the quality of instream flows and improve fisheries conditions
EROSION AND SEDIMENTATION	+ Soil conservation measures will reduce rapid runoff and improve infiltration into aquifers	+ Erosion and sediment laws will improve urban runoff + Soil conservation measures will retain soil and reduce nutrient, pesticide, and sediment loadings - Conservation tillage may require more fertilizers and pesticides + Streambank protection will improve water quality of streams		+ Recommended P.L. 566 watershed projects will reduce flooding damages by reducing rapid runoff + Streambank protection measures will reduce flood damages by diminishing scour	+ Improved land management will enhance the aesthetics of the basin	+ Soil conservation measures will improve fish production and survival and will slow conversion of wetland habitat - Some habitat may be altered or destroyed by P.L. 566 Watershed Projects (mitigative measures may be provided)	+ Streambank protection measures may reduce dredging requirements in the navigation channel		+ Small instream impoundments implemented through P.L. 566 Watershed Projects may stabilize instream flows - Small upstream impoundments will increase evaporation
FLOOD DAMAGE	+ Decreasing runoff rates through stormwater management, floodplain and wetland preservation, and land treatment will improve aquifer recharge capability	+ Wetland preservation and restoration and floodplain preservation and evacuation will maintain water quality by continuing natural filtration	+ Maintaining or increasing floodwater storage will reduce flood peaks and subsequent increases in streambank erosion + Maintaining floodplain vegetation will prevent increasing streambank erosion - Channel modification may increase erosion		+ Acquisisiton and evacuation of floodplains will provide additional riverside recreation areas + Preservation or restoration of wetlands will increase hunting and other recreational opportunities	+ Preservation and restoration of wetlands will provide wildlife habitat + Preservation of floodplain vegetation will maintain wildlife habitat - Upstream reservoirs, channel modification, and levee construction may damage fish and wildlife habitat			+ Upstream reservoirs would maintain instream flows + Maintaining floodwater storage would stabilize instream flows
WATER RECREATION		+ Preservation and protection of additional streams will prevent water quality violations from development in river valleys and along streambanks + Monitoring recreation rivers will identify water quality problem areas accentuated by recreation use	+ Preservation and protection of additional streams will assist in controlling erosion and sedimentation from adjacent farmlands + Monitoring access to recreation sites will identify over-utilized accesses that accentuate erosion			+ Authorization of the Meramec River Recreation Area and the "greenbelt area" near Des Moines and protection of scenic rivers and natural areas will preserve fish and wildlife habitat - Development of access and facilities in recreation areas will disrupt habitat and disturb an area's natural state	+ Improved safety procedures and enforcement of regulations concerning lockage waiting areas, boat mooring, lighting, and control structures will reduce conflicts between recreational and commercial boating		
FISH AND WILDLIFE	+ Wetland preservation will maintain aquifer recharge capability	+ Wetland preservation will maintain natural water filtration and abate degradation of water quality	+ Increased funding for mitigation of channel maintenance activities by the Army Corps of Engineers may result in rehabilitation of backwaters that are filling in with sediments	+ Preservation of wetlands will maintain floodwater storage	+ Wetland preservation will provide areas for wildlife related recreation + Increased funding for sport fish restoration and management will improve sport fisheries + Increased mitigation of channel maintenance by the Army Corps of Engineers will improve recreation on the Mississippi River				+ Wetland preservation will prevent further acceleration of surface water runoff and resultant flow fluctuation
NAVIGATION		+ Use of efficient dredging equipment and measures to prevent re-erosion of material into the channel will maintain water quality	+ Alternative dredged material disposal and finding productive uses for dredged material will prevent erosion of dredged material placement sites	+ Disposing of dredged material outside the floodplain will prevent increases in the flood stage	+ Additional funding for dredged material placement activities would allow better use of material for recreation facilities	+ Additonal funding for dredged material placement activities would allow increased consideration of fish and wildlife habitat - Additional fleeting and terminal areas would disturb habitat			
ENERGY	+ Alternative energy sources will reduce the projected demand for steam-electric generation and water consumption + Conservation will reduce electrical generation and enhance water supply	+ A study of the potential for acid rain from scheduled steam-electric plants may lead to stricter air quality standards and improved water quality				+ Alternatives to steam-electic generation will reduce the demand for power plants and associated water use, which will improve instream flow and habitat			+ Alternative energy sources will reduce the projected demand for steam-electric generation and enhance instream flows + Power production at smaller steam-electric plants may reduce effects on stream flow
INSTREAM FLOW	- "Protected flow" regulations will restrict water use (conservation measures may minimize effect)	+ Instream flow management will maintain the assimilative capacity of streams and reduce costs of advanced waste treatment			+ Instream flow analyses will improve planning for recreation	+ Instream flow analyses will improve planning for fish and wildlife habitat		+ Instream flow analysis will aid in siting steam-electric plants	

+ positive effect
- negative effect
( ) mitigative measure

ENVIRONMENTAL ASSESSMENT SUMMARY

The water resources management plan for the Upper Mississippi Region which includes its fourteen subregions, in conjunction with their environmental assessment summaries, functions as an "environmental impact statement" in compliance with Section 102, (2)(c) of the National Environmental Policy Act of 1969, as amended. Subsequent actions taken by federal, state, or local agencies in the implementation of plan recommendations will necessitate a more thorough environmental analysis and detailed environmental impact statement to satisfy both the national and the state environmental policy requirements.

This summary reviews the environmental evaluation that is an integral part of the water resources management plan. The evaluation is based on the four account system of the U.S. Water Resources Council's Principles and Standards for water and related land resources planning. Proposed alternatives are evaluated for their anticipated effects on national economic development (NED), environmental quality (EQ), regional economic development (RED), and other social effects (OSE) and are displayed in the "alternative solutions: analysis and evaluation" table for each water and related land resources topic. A further evaluation on the efficiency and acceptability of each alternative in relation to other alternatives is also displayed.

Brief Description of Proposed Action

The Upper Mississippi River Basin Commission will transmit to the U.S. Congress and the President, via the Water Resources Council, this water resources management plan for the Upper Mississippi Region which includes Volume I (Regional Plan), Volume II (Subregion), and Volume III (Reference Handbook). The recommendations developed through the plan and contained in Volumes I and II will help guide in the implementation of projects and programs that will solve problems and meet needs for water supply, water quality, erosion and sedimentation, flooding, water recreation, fish and wildlife, navigation, energy, and instream flows.

Relationship of Plan to Existing Programs

Existing programs, laws, regulations, and institutional arrangements were considered in problem identification and plan formulation. Consideration was also given to proposed projects and programs, pending legislation, and anticipated future studies. The plan utilized other studies and results of similar programs such as the Great River Environment Action Team (GREAT) studies and state water planning programs.

Recommendations in the plan for the Upper Mississippi Region generally rely upon existing institutional authorities, statutory requirements, and program structures for ultimate implementation. Some recommendations, however, promote new or expanded programs or increased financial incentives in areas of water conservation, nonpoint pollution control, and erosion control.

Probable Environmental Effects of the Proposed Actions

The recommended actions for solving problems and meeting needs in the Upper Mississippi Region involve structural and nonstructural programs that enhance the overall environmental quality while providing for economic resource development. The recommended actions are contained in Part 3 of this volume and in each of the subregion components of Volume II. The environmental effects of proposed actions are discussed in the "Alternative Solutions and Effects" and "Conclusion" sections of Part 2. At the beginning of Part 4, a summary of the effects of recommended solutions on objectives for water and related land resources also details the general positive and negative effects of recommendations on management objectives and possible measures to mitigate any negative effects.

Consideration of historic and cultural properties during planning for construction is also promoted in this plan. Specific projects that could affect historic or cultural properties are listed in subregion plans, which address local issues.

The components of the recommended plan for water supply are designed to encourage local resource development where local water supplies are available, increased water quantity and quality monitoring, and expansion of water conservation programs. In the Upper Mississippi Region, large surface water development projects have not been necessary except in a few areas where groundwater is limited. Surface water development can influence flows and other environmental concerns because reservoirs alter environmental conditions. Resource monitoring, improved reservoir operations, and water conservation can add further measures for the protection of surface water and groundwater.

The major emphasis of the water quality recommendations encourages the implementation of Best Management Practices because nonpoint pollution is pervasive and severe in the Upper Mississippi Region. Improved wastewater treatment plant operation, and lake restoration should also advance the environmental water quality goals. In addition, major improvements of water quality will be achieved through the completion of wastewater treatment facilities. Expanded monitoring and regulation of toxic and hazardous materials will prevent the degradation of the aquatic environment.

Recommendations for erosion and sedimentation promote improved water quality and long-term soil productivity through increased funding for soil conservation programs and for incentives to farmers and landowners. Completion of the potential watershed projects will help protect nearly 6 million acres from severe erosion and will substantially aid in sediment reduction. These projects, however, may alter habitats or have other negative environmental effects such as wetland drainage and stream channelization. Although the implementation of certain land treatment measures may involve local environmental damage, the overall contribution to sediment and erosion reduction will have beneficial effects on environmental quality. Prime and unique farmlands also will have a greater degree of protection through these recommendations. Streambank protection and sedimentation research will be expanded which will improve water quality and may benefit channel maintenance through decreased dredging requirements.

The components of the recommended plan for flood damage reduction are designed to increase consideration of nonstructural means to reduce flood damages. Increased funding for floodproofing and relocation of residents outside the floodplain is promoted to reduce vulnerability to flooding and to prevent the environmental effects and the subsequent floodplain development that often result from structural measures. Efforts to delineate floodplains, regulate development, and maintain floodwater storage are recommended to prevent additional flood problems. Although structural measures are recommended contingent upon mitigation of environmental effects, some adverse effects would occur from such projects.

Recommendations for water recreation emphasize monitoring participation to identify overand underutilized areas. Other recommendations include additional protection of scenic and natural areas, and promoting boating safety and stricter enforcement of rules. Some facility development for recreation activities will disturb natural areas and wildlife habitat.

The emphasis of fish and wildlife recommendations is to protect and enhance habitat areas including streams, wetlands, floodplains, and natural areas. Positive environmental effects are achieved through all fish and wildlife recommendations.

Commercial navigation recommendations support the need for coordinating structural navigation system improvements with environmental studies to assure habitat preservation. Increased efficiency and safety recommendations are nonstructural means to improve the navigation systems. Measures to reduce the environmental effects of dredging while maintaining the navigation channel are supported.

Recommendations for energy promote conservation, hydroelectric facilities, smaller power plant facilities, and alternative energy sources. These proposals would have a minimal effect on water supply, water quality, fish and wildlife habitat, and instream flows.

Instream flow recommendations encourage greater analysis of flow needs for fish and wildlife habitat preservation and enhancement, water recreation, and for other environmental needs in water planning. Improved coordination of reservoir operations could improve

downstream habitat. Positive environmental effects are achieved through all instream flow recommendations.

Adverse Environmental Effects that Cannot be Avoided Should the Proposals be Implemented

When environmental effects of a suggested action are unknown or dubious, the recommendations propose feasibility studies or detailed planning before implementation is considered. Nevertheless, some environmental effects associated with proposed programs and projects would remain, including the following : inundation of agricultural and wildlife areas for sediment detention basins, fish and wildlife displacement, the presence of project structures, the appropriation of land for flood control projects, the disposal of sludges from high levels of wastewater treatment, increased recreational boating densities associated with improved access and limited use classifications, and temporary increased runoff and sediment loads during excavation and construction operations. Project effects are further assessed during the study process and documented in the project reports.

Alternatives to the Proposed Actions

This volume in Part 2 and the subregion components in Volume II, present an array of alternatives within each of the functional areas. The alternatives, which include structural and nonstructural programs and projects, were evaluated before selection of recommendations. The alternatives were evaluated for their effects on national economic development, environmental quality, regional economic development, and other social effects, in addition to their efficiency and acceptability. The alternative of "no action" was also considered in the analysis. Specific information is contained in the alternative solutions table of each topic.

Short-term Uses of Resources and Long-term Economic Productivity

The water resources management plan for the Upper Mississippi Region outlines a continuing plan which incorporates short-term management and study proposals with longer-term alternatives and guidelines for satisfying future water and related land resources problems and needs. Nearly all the elements of the plan have proposals which address both the near-term needs as well as the longer-term management arrangements necessary for effective resource conservation and development. The schedule of recommendations is included in Part 3.

Recommendations for water supply not only encourage local development and improved surface water management but also a broader program of conservation and monitoring to preserve water supply resources. The water quality proposals promote immediate treatment improvement at existing wastewater treatment facilities and long-term nonpoint pollution control programs. Erosion and sedimentation recommendations recognize the need for continued agricultural productivity and the soil retention programs necessary to maintain productivity. Recommendations for flood damage reduction are directed toward mitigation of damages in local unprotected areas in addition to providing for re-evaluation of justification criteria for long-range planning. Water recreation, fish and wildlife, and instream flow proposals are designed to enhance long-range planning capabilities while preserving and enhancing current resources. Recommendations for energy reflect the need for power plant development but only after adequate planning details their effects. Similarly, navigation recommendations support system improvements but not to the detriment of the environment.

Overall, the environmental well-being of residents in the Upper Mississippi Region would be improved without sacrificing long-range productivity. In addition, several proposed or expanded programs would initiate appropriate mechanisms for more effective future planning and implementation.

Irreversible Commitments of Resources

Recommended actions are designed to maintain many options for resource use and to limit irreversible commitments of resources. By directing the recommendations toward management authorities, institutional arrangements, and policy alternatives rather than proposing structural projects, the Upper Mississippi Region Plan maintains the flexibility necessary for effective resource management in the future. Implementation of the proposed programs and policies is intended to strengthen the ability of federal, state, and local agencies to deal with long-range planning issues and avoid the loss of valuable resources. However, the implementation of the projects will result in irreversible commitments of resources. These effects are presented in the individual project reports. The cummulative effect is judged to be acceptable from the regional perspective.

APPENDIX A Excerpts from the 1965 Water Resources Planning Act

(Relative to the creation and duties of a River Basin Commission, from: Water Resources Council, Public Law 89-80, 89th Congress, July 22, 1965: Water Resources Planning Act, 1967.)

Water Resources Planning Act

SECTION 1. This Act may be cited as the "Water Resources Planning Act".

SECTION 2. In order to meet the rapidly expanding demands for water throughout the Nation, it is hereby declared to be the policy of the Congress to encourage the conservation, development, and utilization of water and related land resources of the United States on a comprehensive and coordinated basis by the Federal Government, States, localities, and private enterprise with the cooperation of all affected Federal agencies, States, local governments, individuals, corporations, business enterprises, and others concerned.

Creation of Commissions

SECTION 201. (a) The President is authorized to declare the establishment of a river basin water and related land resources commission upon request therefore by the Council, or request addressed to the Council by a State within which all or part of the basin or basins concerned are located if the request by the Council or by a State (1) defines the area, river basin, or group of related river basins for which a commission is requested, (2) is made in writing by the Governor or in such manner as State law may provide, or by the Council, and (3) is concurred in by the Council and by not less than one-half of the States within which portions of the basin or basins concerned are located and, in the event the Upper Colorado River Basin is involved, by at least three of the four States of Colorado, New Mexico, Utah, and Wyoming or, in the event the Columbia River Basin is involved, by at least three of the four States of Idaho, Montana, Oregon, and Washington. Such concurrences shall be in writing.

(b) Each such commission for an area, river basin, or group of river basins shall, to the extent consistent with section 3 of this Act--

(1) serve as the principal agency for the coordination of Federal, State, interstate, local and nongovernmental plans for the development of water and related land resources in its area, river basin, or group of river basins;

(2) prepare and keep up to date, to the extent practicable, a comprehensive, coordinated, joint plan for Federal, State, interstate, local and nongovernmental development of water and related resources: Provided, that the plan shall include an evaluation of all reasonable alternative means of achieving optimum development of water and related land resources of the basin or basins, and it may be prepared in stages, including recommendations with respect to individual projects;

(3) recommended long-range schedules of priorities for the collection and analysis of basic data and for investigation, planning, and construction of projects; and

(4) foster and undertake such studies of water and related land resources problems in its area, river basin, or group of river basins as are necessary in the preparation of the plan described in clause (2) of this subsection.

Duties of the Commission

SECTION 204. Each river basin commission shall--

(1) engage in such activities and make such studies and investigations as are necessary and desirable in carrying out the policy set forth in section 2 of this Act and in accomplishing the purposes set forth in section 201(b) of this Act;

(2) submit to the Council and the Governor of each participating State a report on its work at least once each year. Such report shall be transmitted through the President to the Congress. After such transmission, copies of any such report shall be sent to the heads of such Federal, State, interstate, and international agencies as the President or the Governors of the participating States may direct;

(3) submit to the Council for transmission to the President and by him to the Congress, and the Governors and the legislatures of the participating States a comprehensive, coordinated joint plan, or any major portion thereof or necessary revisions thereof, for water and related land resources development in the area, river basin, or group of river basins for which such commission was established. Before the commission submits such a plan or major portion thereof or revision thereof to the Council, it shall transmit the proposed plan or revision to the head of each Federal department or agency, the Governor of each State, and each interstate agency, from which a member of the commission has been appointed, and to the head of the United States section of any international commission if the plan, portion or revision deals with a boundary water or a river crossing a boundary, or any tributary flowing into such boundary water or river, over which the international commission has jurisdiction or for which it has responsibility. Each such department and agency head, Governor, interstate agency, and United States section of an international commission shall have ninety days from the date of the receipt of the proposed plan, portion, or revision to report its views, comments, and recommendations to the commission. The commission may modify the plan, portion, or revision after considering the reports so submitted. The views, comments, and recommendations submitted by each Federal department or agency head, Governor, interstate agency, and United States section of an international commission shall be transmitted to the Council with the plan, portion, or revision; and

(4) submit to the Council at the time of submitting such plan, any recommendations it may have for continuing the functions of the commission and for implementing the plan, including means of keeping the plan up to date.

APPENDIX B Preparation of Water Resources Management Plan

(Excerpts from: Upper Mississippi River Basin Commission, Comprehensive Coordinated Joint Plan, Plan of Study: Adopted by the Commission at the May 10, 1977 Quarterly Meeting, June 1977.)

Purpose

The overall purpose of water and related land resources planning

> . . . is to promote the quality of life, by reflecting society's preferences for attainment of the objectives defined below:
>
> - To enhance national economic development by increasing the value of the Nation's output of goods and services and improving national economic efficiency.
> - To enhance the quality of the environment by the management, conservation, preservation, creation, restoration, or improvement of the quality of certain natural and cultural resources and ecological systems. (p. 3)

The Commission defined the Water Resources Management Plan (formerly the Comprehensive Coordinated Joint Plan) as:

> "A specific document composed of elements approved and adopted by the Upper Mississippi River Basin Commission, identifying those water and related structural and nonstructural projects, programs, and other measures designed to enhance the economic, environmental, and social conditions of the area..." (p.2)

The objective of the plan

> . . . is to provide information to decision-markers at all levels of government regarding recommended solutions to critical water and related land resource problems, opportunities, and needs. Solutions will provide a substantive approach towards resolving problems and clarify institutional responsibilities to implementing recommended solutions by delineating the role of Federal, State, and local agencies and private interests. (p. 4)

Schedule

The Plan of Study adopted by the Commission divides plan preparation into four phases (p. 43):

Phase 1--Plan of Study Announcement and Development of First-Cut CCJP, which summarizes the 1975 National Water Assessment and other planning studies

Phase 2--Completion of water resources subregion plans for the fourteen river basins in the region

Phase 3--Integration of the subregion plans into a regional Water Resources Management Plan

Phase 4--Water Resources Management Plan Formal review, Commission approval, and submittal to Water Resources Council

APPENDIX C Excerpts from the U.S. Water Resources Council, *Policy Statement No. 4: The Utilization of Comprehensive Regional Water Resources Management Plans, 1 January 1979*

I. PREAMBLE

This policy statement establishes Water Resources Council (WRC) policy for the implementation of Federal portions of regional water resource management plans.

II. EFFECTIVE DATE

This policy is effective January 1, 1979.

III. DEFINITIONS

A. Consistency. The term "consistency" as used in this statement means that Federal water and related resource activities are carried out in agreement with regional plans to the maximum extent practicable.

B. Approved Regional Plan. An "approved regional plan" is a comprehensive water resource management plan adopted by a river basin commission or other Council-designated regional entity, or by the Council following appropriate review and comment under statutory or other requirements of Federal agencies, and in consultation with affected States. Such plan or revision adopted or approved in this manner shall be the "approved regional plan." The plan shall include an evaluation of all reasonable alternative means of achieving development of water and related land resources of the region reflective of the region's preference between the two national objectives of National Economic Development and Environmental Quality.

C. Regional Entity. A "regional entity" is a Title II (P.L. 89-80) river basin commission, a Federal-Interstate Compact Commission approved by Congress and the respective state legislatures, or other regional organization designated by the Council in conjunction with the affected States, to function similar to a Title II river basin commission. The Council may designate itself to act as a "regional entity" where no Title II river basin commission or Federal-Interstate Compact Commission exists.

IV. PURPOSE

This statement provides the policy of the Water Resources Council for the utilization of approved regional water resource management plans in order to improve the efficiency and effectiveness of comprehensive planning.

V. POLICY

Federal agency water and related land resource programs and projects shall be consistent with approved regional water resource management plans or satisfactory reasons for the inconsistency shall be given by the responsible Federal agency.

Federal projects and programs required to be formulated and evaluated under the WRC Principles and Standards (P&S) may be found not fully in accord or consistent with goals and objectives desired by regional planning entities not bound by the requirements of the P&S. This occurrence, because of the required application of P&S, will be prima facie evidence of a satisfactory reason for inconsistency.

VI. CONSISTENCY CERTIFICATION

A statement shall be included with the annual budget submission of each member agency to the Office of Management and Budget (OMB) which (1) certifies that the agency budget submission is consistent with the appropriate regional water resource management plan(s), or (2) provides reasons satisfactory to the President such as statutory requirements or overriding national priorities or constraints, such as application of Principles and Standards, for those exceptions where the budget submission is inconsistent with the appropriate plan(s).

VII. FEDERAL ACTIVITIES COVERED

Direct Federal Activities--This policy on consistency covers the water related land resource planning and implementation studies, land acquisition and construction and specified operational activities of the member agencies shown below.

Department of Agriculture

Forest Service

National Forest Service Management
Wilderness Area Recommendations
Wild and Scenic Recommendations

Department of the Army

Corps of Engineers

General Investigations[1]
Construction General[2]
Flood Control, Mississippi River and Tributaries[3]

Federally Assisted Activities--States and local governments exercise the primary initiative and control of implementation activities supported by Federal assistance programs by: assessing the needs for projects, preparing comprehensive plans, establishing priorities for projects and development activities, and coordinating such planning and development activities through procedures established by OMB Circulars A-95 and A-111. Consistency or compatibility of the federally supported activities shown below with approved regional water resources plans should be assured, insofar as practicable, by the state and local governments through the coordination procedures promulgated by the above Circulars.

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[1]Excluded are such activities as those surveys not oriented toward implementation of Army Corps of Engineers projects (such as Coordination with Other Agencies and non-federal Interests), Collection and Study of Basin Data, and Research and Development.

[2]Excluded are miscellaneous small categories not involving construction of new Army Corps of Engineers projects or project elements, such as Small Projects for Mitigation of Shore Damages Attributable to Navigation Projects, Emergency Stream Bank and Shoreline Protection, Aquatic Plan Control, etc.

[3]Excludes maintenance.

Department of Agriculture

Soil Conservation Service

Small Watershed Programs
Resource Conservation and Development Water Resource Measures
Cooperative River Basin Studies

Forest Service

Cooperative Programs
YCC (Youth Conservation Corps)

Department of the Interior

Fish and Wildlife Service

Fish and Wildlife Restoration (Pittman-Robertson)
Fish and Wildlife Restoration (Dingell-Johnson)

Heritage Conservation and Recreation Service

Land and Water Conservation Fund

Bureau of Reclamation

Loan Programs - Small Reclamation Projects (P.L. 84-984)
- Distribution Systems (P.L. 84-130)
- Irrigation Systems (P.L. 81-385)
Rehabilitation and Betterment Programs

APPENDIX D Excerpts from the U.S. Water Resources Council's "Proposed Rules; Principles, Standards, and Procedures for Planning Water and Related Land Resources"

(from: U.S. Water Resources Council, "Proposed Rules; Principles, Standards, and Procedures for Planning Water and Related Land Resources," Federal Register Volume 45 No. 73. Part II, (14 April 1980). pp. 25302-25308.

Introduction

SECTION 710.1 Purpose

These Principles establish rules to be followed by the Water Resources Council (WRC) and WRC-designated agencies in planning Federal and Federally-assisted water and related land resource programs and projects. Their purpose is to establish uniformity in water and related land resources planning. They provide the basic policy for the Standards and the Procedures.

SECTION 710.2 Scope

(a) These Principles cover water and related land resources planning. They establish the basic process to be followed by river basin commissions and Federal agencies and specify how each phase of the process is to be performed.

(b) The national objectives and accounts covered by these Principles incorporate and are consistent with the concept of human environment as used in the National Environmental Policy Act of 1969 (NEPA) (42 U.S.C. 4321-4361) and the appropriate portions of the NEPA process regulations established by the Council on Environmental Quality (CEQ) in 40 CFR Parts 1500-1508.

SECTION 710.4 Applicability

(a) These Principles apply to the following three levels of Federal Water and related land resources planning as defined by WRC:

(1) Level A--framework studies and assessments. Level A planning studies are broad-based evaluations or appraisals designed to ascertain the desirability of conservation, development, and utilization of water and related land resources. These studies identify problems and opportunities in the nation, regions, river basins, and specific areas.

(2) Level B--regional and river basin studies that lead to a recommended plan. Level B planning studies are planning efforts to provide input to, or be adopted as, comprehensive, coordinated water resources plans, or portions thereof, for regions or river basins. Level B studies include strategies, policies, and programs which provide a basis for detailed studies and actions leading to implementation of Federal, State, and local government programs. Comprehensive studies specifically authorized by the Congress are to be carried out to the extent necessary to fulfill their statutory requirements.

(3) Level C--implementation studies. Level C studies are program or project feasibility studies generally undertaken by a single Federal agency and which are expected to result in project authorization, funding, and implementation. These studies are conducted in response to findings and conclusions identified in assessments and regional and river basin studies, or in direct response to national, or local problems and opportunities.

(b) These Principles are to be implemented by WRC and are to be applied by river basin commissions, WRC-designated Federal-State organizations, compact commissions for studies funded by WRC, and WRC-designated Federal agencies.

General Planning Considerations

SECTION 710.11 General Setting--projections

(a) Formulation and evaluation of alternative plans are to be based on the most likely conditions expected to exist in the future with and without the plan. The projection of withand without-plan conditions is to be based on national and regional projections of income, employment, output, population, and land use trends, the amounts of goods and services likely to be demanded and expected environmental conditions. The without-plan condition is the condition expected to prevail in the absense of any alternative plan in study and is the same as the alternative of taking no action.

(b) National projections used in planning are to based on a reasonably full employment economy. This does not preclude consideration of special analyses of regions with high rates of unemployment and underemployment in calculating benefits from using unemployment and underemployed labor resources.

Alternative Plans

SECTION 710.51 Required alternative plans

Alternative plans are to include: a national economic development plan, an environmental quality plan, and a primarily nonstructural plan. These particular plans are required to ensure that consideration is given to the widest practical range of alternative plans. The concept of a practical alternative plan means that the NED or EQ plan include elements which address the other objective.

(a) National economic development plan--A plan that maximizes net contributions to the NED objective is to be included as one alternative. This plan is to be systematically formulated to alleviate the specific problems and take advantage of the specific opportunities that define the NED objective for the relevant planning area. If no such plan can be formulated, the no action alternative is the NED plan.

(b) Environmental quality plan--A plan that maximizes net contributions to the EQ objective is to be included as one alternative. This plan is to be systematically formulated to alleviate the specific problems, take advantage of the specific opportunities, and preserve the specific attributes that define the EQ objective for the relavant planning area. If no such plan can be formulated, the no action alternative is the EQ plan.

(c) Primarily nonstructural plan--(1)A "primarily nonstructural" plan is to be formulated and included as a candidate plan (See Section 710.90) whenever structural project or program alternatives are considered.

(2) A primarily nonstructural plan is the plan that makes maximum feasible use of nonstructural measures to address water resource problems and opportunities. The determination of maximum feasible use will be based on the maximum use of nonstructural measures that contribute to the NED and the EQ objectives.

(3) Nonstructural measures are complete or partial alternatives to the traditional structural measures for addressing water resources problems and opportunities. The ideal nonstructural alternative is the least cost, implementable modification in public policy, management practice, regulatory policy, or pricing policy that would bring marginal benefits and marginal costs for each project output into equality. The NED and EQ objectives are to serve as the basis for the measurement of costs and benefits.

Accounts

SECTION 710.60 General

(a) This subpart applies to Level B and Level C studies.
(b) Four accounts are to be used in organizing the information on effects of candidate plans (See Section 710.90). These four accounts are: national economic development (NED), environmental quality (EQ), regional economic development (RED), and other social effects (OSE). These four accounts encompass all significant effects of a plan on the human environment as required by NEPA and on social well-being as required by Section 122 of the Flood Control Act of 1970 (Pub. L. 91-611, 84 Stat. 1823).

Planning Process

SECTION 710.100 Level B and Level C studies

(a) Level B and Level C water and related land resources planning consists of the following major steps:
(1) Specify the water and related land resources problems and opportunities (relevant to the planning setting) associated with the NED and EQ objectives;
(2) Inventory and analyze water and related land resource conditions within the planning area;
(3) Formulate alternative plans;
(4) Evaluate the effects of the alternative plans;
(5) Compare alternative plans; and
(6) Select a recommended plan based upon the comparison of alternative plans.
(b) Plan formulation is a dynamic process whose various steps should, at a minimum, be reiterated one or more times. This reiteration process, which may occur at any step, may sharpen the planning focus or changes its emphasis as new data are obtained or as the specification of problems or opportunities change or becomes more clearly defined.

APPENDIX E Definition of Components in the "Proposed Rules; Principles, Standards, and Procedures for Planning Water and Related Land Resources"

(Developed by UMRBC-CCJP Research Staff based on U.S. Water Resources Council, "Proposed Rules; Principles, Standards, and Procedures for Planning Water and Related Land Resources" Federal Register Volume 45 No. 73 Part II, (14 April 1980).

National Economic Development (NED)

Beneficial effects are increases in the economic value of the national output of goods and services and improvements in national economic efficiency. Adverse effects are the total economic values of resources required for or displaced by the plan, including project outlays and uncompensated economic losses.

Agricultural Output: A measure of the value or quantity of increased or decreased agricultural production or efficiencies.

Commercial Output: A monetary measure of the value of increased or decreased retail goods or their marketability, and includes the increased availability and value of water supplies.

Energy Output: A monetary value which measures the beneficial or adverse effects a project or program will have on energy process, consumption, and conservation.

Federal Cost: The portion of a project or program funded by the United States government. Federal costs include those associated with administration of a project or program and includes the cost of planning, designing, engineering, construction and maintenance.

Industrial Output: A monetary measure of the value of increased or decreased production of manufactured goods.

National Cost: The portion of a project or program funded by the nation which includes federal, state, local, and private costs. National costs include those associated with administration of a project or program and includes the costs of planning designing, engineering, construction, and maintenance.

Navigation: A monetary value which measures the beneficial or adverse effects a project or program will have on commercial navigation.

Reduced Disaster Assistance: The effect a project or program has on reducing federal costs for disaster assistance programs.

Service Output: A monetary measure of the value or quantity of increased or decreased human services or their availability. Service output includes the value of increased recreational and educational opportunities.

Environmental Quality (EQ)

Beneficial effects are increases in the quantity or improvements in the quality of biological, historic, scientific, educational, or pristine values of natural and cultural resources. Adverse effects are decreases in the quantity or reductions in the quality of these values.

Erosion Control: The net effect a project or program will have in controlling all forms of soil erosion and in promoting land stabilization.

Fish and Wildlife Habitat: The beneficial and adverse effects a project wll have on the flora and fauna of an area, including species population and diversity.

Groundwater Quality: The net effects a project or program will have on the quality of a region's groundwater.

Instream Flows: The net effects a project or program will have on the maintenance of flow requirements for waste dilution, irrigation, propagation of fish and wildlife, recreation, and energy.

Natural Areas: The beneficial and adverse effects a project or program will have on open and green space, wild and scenic rivers, lakes and beaches, wilderness areas and other areas of natural beauty and archaeological, historical, biological and geological significance and selected ecological systems.

Sediment Control: The net effect a project or program will have on reducing or eliminating sediment deposition in streams, rivers and lakes and the associated adverse effects on water quality and fish and wildlife habitat.

Surface Water Quality: The net effects a project or program will have on the quality of a region's surface waters.

Regional Economic Development (RED)

Beneficial and adverse effects are changes in regional income and employment. These effects are measured in monetary and nonmonetary terms and are categorized according to outlays, associated costs, and external diseconomies.

Economic Stability: The net effect of a project or program in providing long-term employment and income to residents of an area which includes the regional benefits of improved agricultural, commercial, industrial, energy, and service output.

Flood Damage Reduction: The net effect a project or program will have on reducing local and regional flooding problems and associated damages.

Jobs: The net contribution a project or program will have on increased or decreased employee numbers and earnings (private and government employees).

Local Costs: The portion of a project or program paid for by local tax dollars.

Population Distribution: The effect a project or program will have on settlement patterns in a given region as related to the costs of providing services to that region.

Private Cost: The portion of a project or program funded by private individuals, groups, or industries.

State Costs: The portion of a project or program funded by the respective participating or sponsoring states.

Water Supply: The net effect a project or program will have on regional water supplies, conservation and use.

Other Social Effects (OSE)

Beneficial or adverse effects not covered in the other accounts including urban and community impacts; changes in income and wealth distribution; the quantity or quality of life, health, safety factors; educational and recreational opportunities; and emergency preparedness. These effects are measured in monetary and nonmonetary terms.

Aesthetics: The beneficial and adverse effects on the beauty of an area or its pleasing qualities as perceived by society as a whole.

Culture: The net effects of a project in preserving or promoting cultural opportunities for the residents of a region such as historic or scientific areas, as well as human cultural patterns.

Displacement of Homes/People: The net effects of a project or program in displacing and relocating families and residents of an area.

Education: The net effects of a project in providing educational opportunities of the residents in a region.

Emergency Preparation: The beneficial and adverse effects on extending, maintaining, and protecting the national water transportation system, providing flexible reserves of water supplies, providing critical power supplies, providing reserves of food, production potential and conservation of fuels, and protection from flood emergencies.

Health and Safety: The net effects of a project or program in reducing the risk of flood, drought, or in promoting the security of life and health and the development of health care facilities.

Real Income: The effects a project or program will have on the personal or group property values of the residents in an area.

Recreation: The effects of a project or program on development or preservation of aesthetic values and recreation opportunities in an area.

Planning Objective

National Economic Development (NED): Optimum contributions are made to the national economic development objective and the solution has net beneficial economic effects.

Environmental Quality (EQ): Contributions to the environmental quality objective are emphasized. Solutions have net beneficial effects towards the preservation or enhancement of the environment.

Nonstructural (NS): An alternative that makes maximum use of nonstructural measures to address water resource problems, and makes optimum contributions to either the national economic development objective or the environmental quality objective.

Unrated (Blank): Solution fails to optimize either NED or EQ planning objectives.

Efficiency and Acceptability

Efficiency: This test requires that among acceptable alternatives, the given alternative is cost-effective in alleviating problems and realizing opportunities associated with the NED, EQ, and NS planning objectives.

Acceptability: This test refers to the viability of the alternative in terms of acceptance to the public and compatibility with known institutional constraints.

The rankings (High, Medium, Low) are a relative evaluation of efficiency and acceptability among feasible alternatives. "High" represents most efficient or most acceptable; "Medium" represents efficient or acceptable in some situations, or requires additional study; and "Low" represents least efficient or least acceptable.

Conclusion

Recommended: Solutions judged to best fulfill the objectives of the plan. These solutions would provide the greatest net benefit effects for NED, EQ, RED, and OSE in relation to other alternatives, and are judged most efficient and acceptable.

Conditionally Recommended: Solutions judged to fulfill the objectives of the plan in certain situations. These solutions are for specific areas or are contingent upon a worsening problem or a local evaluation of effects or needs.

Study: Those solutions judged potentially feasible but additional information is necessary before implementation.

Not Recommended: Those solutions judged to provide fewer beneficial NED, EQ, RED, and OSE effects and therefore, are less efficient or less acceptable than other solutions.

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881-26
21-59

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Department of Health and Human Services	Christopher B. Cohen Director, Region V
Department of Housing and Urban Development	Ronald M. Gatton Regional Administrator, Region V
Department of the Interior	Garrey Carruthers Asst. Secretary of Interior
Department of Transportation	Captain Richard C. Walton U.S. Coast Guard
Environmental Protection Agency	
Federal Emergency Management Agency	Patrick J. Brehaney Region VII Director

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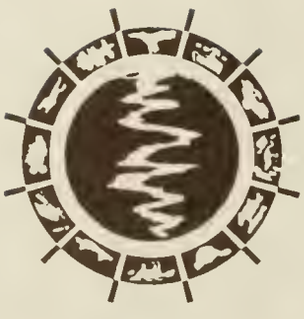

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